INITIAL STUDY OF A COAL GASIFICATION WASTE SITE BROCKVILLE, ONTARIO

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TABLE OF CONTENTS

University of Western Ontario - Regional Collection

1917 - Revision of 1911 Fire Insurance Plan	Sheet 7

Ontario Ministry of Natural Resources

1971 - Airphotographs	31 - 97 and 98
1978 - Airphotographs	141 - 219 and 220

The study site is located on the south side of King Street, west of St. Paul Street and north of Butler Creek, in the town of Brockville, Ontario. It covers an area of approximately 0.5 hectares. The plant was operated by the Brockville Gas Works from 1853 to 1921, then the Brockville Public Utilities Commission from 1921 until 1957, for a total operating life of 104 years. Its approximate layout, obtained from the 1931 Fire Insurance Plan, is shown on Figure 1.

Most of the study site is currently a public parking lot owned by the City of Brockville. However, parts of the former coal gasification plant property now underlie a new building housing an IGA grocery store, and an extension to the existing Brockville Arts Centre (Figure 2). The coal gasification plant buildings were probably demolished and filled over, as was normal practice of the day. Former site structures are superimposed on the current area layout on Figure 2.

PART 2 - TERMS OF REFERENCE

2.1 Study Objectives

The objectives of the study, as specified by the MOE in their request for proposal (RFP) dated October 8, 1987 and summarized in our proposal dated October 26, 1987 are as follows:

1. Evaluate whether or not coal gasification plant wastes are present on the site;

2. If such wastes are present, evaluate how they occur on site (in storage tanks, in soil, etc.) and obtain some indication of their areal distribution;

3. If present, evaluate whether the wastes are contained, or whether wastes or contaminated waters, or both, may be moving off site;

4. If present, evaluate whether or not the wastes are impacting on, or pose an imminent threat of impact on, human health and safety, or the environment, or both.

The objectives have been met in two phases under the following terms of reference (TOR).

2.2 Terms of Reference

2.2.1 Phase 1: Surface Investigation

1. Prior to commencement of work, the MOE notified property owners of the planned study. **TDM** obtained permission from the property owners to undertake necessary work on site.

2. Review available site information with reference to the Inventory of Coal Gasification Plant Waste Sites in Ontario, Volumes I and II (Intera Technologies, 1987).

3. Conduct a detailed search of the site and immediate vicinity using visual, olfactory, and geophysical techniques to locate any buried wastes, or structures possibly containing wastes, produced by the former coal gas plant.

4. Conduct background air quality measurements at the site; specifically to establish levels of the indicators benzene, toluene, and xylene, in the ambient air (Appendix-A). If present, identify possible sources.

5. Discuss findings of Phase I activity with the MOE, to select initial sites for test drilling and groundwater and soil sampling.

2.2.2 Phase 2: Subsurface Investigation

1. Conduct test drilling, including soil and groundwater sampling to confirm whether or not coal tar wastes or derived contamination are present on the site.

2. If coal tar wastes or derived contamination are present, obtain an indication of their extent, and whether or not they are moving off site.

3. Sample and log all boreholes continuously with depth.

4. Install a temporary monitoring well in selected boreholes for subsequent monitoring of groundwater levels and quality. Obtain relative elevations of monitoring wells.

5. Collect samples of sewer water and sediments upstream and downstream of the site.

6. During subsurface investigations, conduct real time air monitoring for the indicators benzene, toluene, and xylene, to detect changes in ambient air quality.

7. Analyze selected samples of soil for benzene, toluene, xylene, and PAH's to evaluate the presence of coal tar contamination.

8. Collect groundwater samples, and analyze for the parameters listed in Appendix B.

9. Prepare a report detailing the investigation, including recommendations for further detailed studies, and remedial work, if necessary.

PART 3 - PHASE 1 - SURFACE INVESTIGATION

As specified in Sections 2.1 and 2.2, the study was undertaken in two phases. Phase 1, a surface investigation, included a visual site inspection, historical records search, geophysical survey, and background air quality measurements. This work was completed between February 15 and April 8, 1988. The information obtained during Phase 1 enabled more detailed planning of borehole and monitoring well locations for Phase 2.

3.1 Study Program

3.1.1 Site Inspection

TDM staff visited the site to inspect the property and identify any surface features that may be indicative of the layout of previous site structures. In addition to the site surface, the banks of Butler Creek were examined for visible signs of seepage, and a number of pipes protruding from the creek bank were examined for visible signs of contaminant flow.

All relevant utility organizations were contacted to stake out and mark buried utility corridors on the site. These represent both potential interferences for the Phase 2 investigation, and potential conduits for contaminant flow.

3.1.2 Electromagnetic Geophysical Survey

Surface geophysics were used to assist in the accurate location of former site structures. Hyd-Eng Geophysics Inc. used a Geonics EM-31 instrument to measure variations in the conductance of shallow materials on site. Bulky, non-conducting materials in the fill, such as remnant concrete tank or building foundations are identified by low conductance values. Steel tanks and similar large metal objects are identified by high conductance values.

The survey was conducted on a grid with northwest trending lines spaced 3 m apart, and measurements recorded at points spaced 2 m apart along each line. Figure 1 of Appendix C shows the survey grid setup. A continuous data recorder was used with the instrument to ensure accuracy of results.

3.1.3 Historical Records Search

In order to gain an understanding of the operation of the plant, all relevant historical maps listed in the Inventory of Coal Gasification Plant Waste Sites in Ontario (Intera, 1987) were examined. To supplement this data, TDM staff visited the Brockville municipal records office and local museums in a search for additional information. None was found at these sources. However, additional bird's eye view maps, and an historical airphotomosaic were located at the Ontario Archives, as listed in Section 1.2. The available historical maps and air photographs were our primary information source in determining the location and layout of buildings and facilities on the site, and the processes which took place in them. The planned distribution of boreholes for Phase 2 investigation was largely based on this information.

3.1.4 Background Air Quality

TDM visited the study site on April 6, 1988 to establish the background air quality.

The instrument used in measuring the air quality was a Photovac TIP1 photoionization detector. This instrument records the potential produced by the ionization of certain gaseous materials, and translates this result into a qualitative, numeric value directly related to the concentration of ionizable vapours in the air. A limitation of this instrument is that it will detect only substances with an ionization potential of less than 10.6 eV. However, several coal tar indicator parameters fall within the detectable range, so that the instrument reacts to the presence of coal tar. These parameters are:

Benzene	9.25 eV
Toluene	8.82 eV
Xylene	8.56 eV
Naphthalene	8.10 eV

Results of air quality monitoring, both during Phase 1 and Phase 2, were intended to serve several purposes. These are:

i) to evaluate whether current site conditions are impacting outdoor air quality in the vicinity of the site.

ii) to evaluate whether current site conditions are impacting air quality in confined spaces in the vicinity of the site.

iii) to evaluate whether study activity produces an impact on air quality in the vicinity of the site.

iv) to provide an indicator in protecting the health and safety of site workers.

To determine the background air quality, a number of sampling stations were set up on and near the site, as shown on Figure 3. Several stations were located in the basement of the Arts Centre, and one in the IGA store. On a typical day, with no nearby construction activity, and the parking lot partially full, measurements of total ionizable vapours in air were then made at each station, for comparison with background measurements upwind of the site.

3.2 Results

3.2.1 Site Inspection

Much of the former coal gasification plant property lies beneath a paved parking lot, and parts of the northeast corner of the site have been built upon by the Arts Centre expansion and the new IGA structure. The south edge of the property, along the north bank of Butler Creek, is covered with large stones, as protection against erosion, and additional fill is periodically placed there by the City of Brockville. As a result, there is no surface evidence of former site structures, and evidence of the presence of contamination is found only along the creek bank.

Black stains on surface material occur on the north bank of Butler Creek, immediately east of the St. Paul Street bridge. The stains occur in a horizontal linear pattern, suggesting seepage of oily material on groundwater but no evidence of current seepage of groundwater or oily contaminants was found during our site visit. Several abandoned pipes protruding from the creek bank were dry. No evidence of past or current contaminant flow in these pipes was found.

The Brockville Works Department has conducted trenching excavation through the site to install new storm and sanitary sewer lines (Figure 4). These excavations reached depths of at least 5 m in some locations. While brick and concrete rubble was frequently found, occurrences of oil or tarlike contamination was not reported by site workers.

The south bank of Butler Creek, within about 40 m of the St. Paul Street bridge, exhibited several occurrences of seepage containing oily substances. This contamination is likely not related to the coal gasification operation. The 1953 airphotomosaic indicates that two large above ground storage tanks were located on the south banks of Butler Creek, near the contamination occurrence.

3.2.2 Electromagnetic Geophysical Survey

Interferences in the geophysical properties of the subsurface were caused by the high density of underground utilities on the site. Therefore, the results of the survey were not as useful in planning borehole locations as was anticipated. Appendix C contains the complete Hyd-Eng Geophysics Inc. report.

Many of the conductive anomalies recorded in the survey resulted directly from current underground services and from current building foundations. Figures 5 and 6 show the approximate locations of several buried services superimposed on the geophysical results. As indicated, several high conductance anomalies, particularly along the north edge of the survey area, appear to be directly related to buried sanitary and storm sewers, buried hydro lines, and various catchbasins and manholes. Three large anomalies, however, could not be explained by the presence of current underground services.

Part of the anomaly labelled as C2 on Figure 5 and I1 on Figure 6 appear circular in nature. According to the 1931 Fire Insurance Plan, a small relief gas holder was located in that position. The anomaly appears to confirm the location of either the tank or its foundation.

A larger anomaly exists in the northwestern quadrant of the survey area. The anomaly is oval in shape, and indicates low conductance values. This anomaly may indicate the presence of poorly compacted fill emplaced following removal of the concrete main gas holder, base, the position of which, according to the 1931 Fire Insurance Plan, is superimposed on Figures 5 and 6.

The high conductance anomalies, labelled C1 on Figure 5 and I2 on Figure 6, may indicate the presence of foundations associated with former site structures. The 1931 Fire Insurance Plan indicates that the south edge of the purifier building is located in this area.

3.2.3 Historical Records Search

An historical search was conducted for the MOE in 1987 by Intera. Their report is entitled "Inventory of Coal Gasification Plant Waste Sites in Ontario, vol I and II". It includes a factual summary of information about the plant and its operation. This information is included in Appendix D. Additional relevant documents that were located in our search are listed in Section 1.2.

3.2.4 Background Air Quality

Background air quality measurements recorded at the site are listed in Table 1. The results show that the concentration of ionizable materials throughout the site is similar to that of the upwind (benchmark) location. This indicates that current site conditions are not impacting outdoor air quality in the vicinity of the site.

Air monitoring in the basement of the theatre yielded results less than the values measured in the parking lot area (Table 1). Negative TIP1 measurements indicate ionizable vapour concentrations of less than those present at the benchmark location. Ionizable vapours in the IGA store were present at concentrations similar to those measured in the parking lot area.

PART 4 - PHASE II - SUBSURFACE INVESTIGATION

4.1 Study Program

4.1.1 Drilling Program

The drilling program was conducted on April 18 to 20, 1988. To evaluate the presence of coal tar wastes or derived contamination in the subsurface, twelve (12) boreholes were advanced. The borehole locations were planned on the basis of the former site structures as indicated on the 1931 Fire Insurance Plan. Borehole locations are shown on Figure 7. As indicated, boreholes 2, 9 and 11 are located in the vicinity of former relief and main gas holders. Borehole 8 is located at the former coal shed. Borehole 10 is located at the former gas purifiers, and boreholes 3 and 4 are at former buildings of unknown use. Boreholes 1 and 12 are located at presumed upgradient locations, north of the former plant facilities, and boreholes 5, 6 and 7 are located along the creek bank, at presumed downgradient locations, south of the former plant facilities.

In order to minimize health risks to site workers, minimize creation of contaminant migration conduits, and maximize the collection of useful data, the following controls were imposed upon the drilling program. Where visibly contaminated soil was found, drilling continued until clean material was encountered. Where coal tar waste was found, drilling was suspended and the borehole completed. Where contaminated soil was not encountered, drilling continued to bedrock or 1 m beneath the water table.

Field classification of soil samples, according to the degree of contamination, was conducted on the basis of visual and olfactory examination of samples. According to field observations, samples were assigned the following designations:

Liquid coal tar	refers to samples containing accumulations of pure coal tar or samples saturated with coal tar.
Visible coal tar contamination	refers to samples containing visible staining by coal tar or coal tar related products, or samples with residual (unsaturated) coal tar in porosity or fractures.
Coal tar odour	refers to samples containing no visible evidence of coal tar contamination, but which emanate a distinct coal tar (naphthalene) odour.

Seven (7) boreholes (Figure 7) were instrumented with monitoring wells constructed of 30 mm diameter solid PVC pipe with a 0.9 m length of slotted screen. A sand pack capped with bentonite was placed around each screen. Auger cuttings were used to backfill the borehole to about one (1) metre below ground surface where the hole was sealed with bentonite to prevent communication of surface water and groundwater. The wells were protected from parking lot traffic using cast iron casings and caps installed just below the parking lot surface. A typical monitoring well is shown in Figure 8.

4.1.2 Groundwater Monitoring and Sampling

The groundwater was monitored and sampled on April 28 and June 1, 1988, using a PVC bailer. Two well volumes were removed from the well prior to collection of a sample for analysis. Initial monitoring well liquid samples were left unfiltered, with no attempt at separation of immiscible phases. Subsequent groundwater samples were collected with a bailer as described above, then following separation of immiscible phases and settlement of solids, the clear water was drained into a separate sample container. All waste water generated during sampling was discharged to the sanitary sewer. The water samples have been stored in TDM's sample library.

4.1.3 Storm Sewer and Stream Sampling

Storm sewers and catchbasins on the site were identified during the initial site inspection. A manhole near borehole 8 accepts discharge from one active storm sewer and two presumably abandoned storm sewers. One of the abandoned pipes appears to run eastward, across the plant property. Water and sediment samples were collected from the manhole to evaluate whether coal tar wastes or derivative wastes had accumulated in the bottom. The manhole contained approximately 0.1 m of sediment, and 0.3 m of standing water on the day of sampling. The samples did not appear, on visual inspection, to have been contaminated by coal tar wastes. Following on site examination, these samples were sealed and stored in the TDM sample library.

Butler Creek, immediately south of the study site was sampled at locations upstream, downstream and adjacent to the site (Figure 7). Due to high water conditions at the time of sampling, sediment samples were obtained at each location from the south bank of the creek. Additional sediment sampling was conducted in the fall of 1988, by collection of a sediment core from the center of the creek. Each sediment sample was analysed for evidence of contaminant

migration from the site. Stream water samples were obtained at both upstream and downstream locations, relative to the site.

4.1.4 Chemical Analyses

Four groundwater samples were selected for analysis of the parameters listed in Appendix B, and four soil samples, collected during drilling, were selected for PAH and light volatile hydrocarbon (BTX) analysis. One storm sewer sediment sample and three stream sediment samples were also submitted for BTX and PAH analysis.

4.2 Results

4.2.1 Geology and Soils

The site is underlain by shallow igneous bedrock of the Canadian Shield. Erosion has produced an undulating bedrock surface which outcrops south of Butler Creek. Native overburden deposits at the site consist of glacial and fluvial sand and silty sand with gravel. Fill of varying content and thickness covers the entire site.

Field Results

Borehole depths varied from 2.0 metres to greater than 6.0 metres (Appendix E). Boreholes 1, 2, 3, 4, 6, 7,8 and 12 encountered refusal. Due to the alignment of topographical bedrock highs evident south of Butler Creek, these refusals may indicate bedrock. However, buried concrete building foundations, tank foundations, or other structures may also have caused refusal. The elevations at which refusal were met have been contoured on Figure 9. The surface indicated by the contours may represent the bedrock surface in some areas, but other solid objects causing refusal may result in deviations of the contours from the true bedrock surface. Boreholes 5, 9, 10 and 11 were completed prior to contacting bedrock, due to the presence of either coal tar water or groundwater.

Fill encountered during drilling consists of sand, silt, gravel, ash, brick and concrete fragments, wood, slag, coal and engineered fill (pavement subgrade). Fill thickness ranges from 1.2 metres to 5.4 metres.

Coal tar odours within soils and fill were observed in all boreholes except BH6 and BH11 (Figure 10). However, the degree of odour varied. For example, boreholes BH3 and BH4 emanated coal tar odours from all samples, to borehole completion, while borehole BH5 emanated coal tar odours only from those samples below 3.0 meters depth. Boreholes BH9 and BH12 emanated faint coal tar odours from samples within a discrete depth horizon, with no evidence of odours above or below that horizon (Appendix E).

Visible evidence of the presence of coal tar was seen in only seven boreholes, located primarily in the east half of the property. The visible contamination was similar in appearance and odour at all locations at which it was observed. The substance, hereafter referred to as liquid coal tar, was a brown to gold viscous fluid emanating a naphthalene or creosote-like odour.

Visible coal tar contamination was observed at boreholes BH1, BH2, BH3, BH4, BH5, BH7 and BH8. It generally occurred within fractures in either the fill or the native material. Generally, the visible coal tar contamination was restricted to samples from depths of greater than 2.0 meters below the ground surface. In addition, boreholes BH1, BH2, BH3, and BH7, contained a thin liquid coal tar saturated zone immediately above the level at which refusal was encountered. This may indicate that dense non-aqueous phase liquid (DNAPL) components of the tar have been migrating downward and have been accumulating at the bedrock surface or the surface of other impermeable objects. The depths to refusal in those boreholes at which an accumulation of coal tar was observed, range from 3.0 to 4.8 meters below ground surface. Figures 10 and 11 show the estimated areal and vertical extent of coal tar contamination observed.

Two of the areas that coal tar contamination was expected, specifically in the vicinity of the former main gas holder and the former gas purifier house, did not contain visual evidence of coal tar residues. However, faint coal tar odours were identified in two of the three boreholes (BH 9 and BH 10) in these areas. The base of the former gas holder and the foundation of the former gas purifier house were not encountered during drilling.

Soil Chemistry

Four (4) borehole soil samples were selected on a worst case basis and analysed for volatile hydrocarbons and polynuclear aromatic hydrocarbons (PAH). Results of chemical analyses are included in Appendix F. Samples BH1-5, BH2-4 and BH4-5 contain volatile

compounds in concentrations less than 1000 ppb (parts per billion). Sample BH7-5 contains volatile compounds exceeding 300,000 ppb.

Samples BH1-5 and BH4-5 contain individual PAH compounds in concentrations less than 10,000 ppb. Sample BH2-4 contains naphthalene at 77,300 ppb. Other PAH compounds are present in concentrations less than 15,000 ppb. Sample BH2-5 contains PAH compounds in concentrations less than 10 ppb.

4.2.2 Groundwater

Field Monitoring

Monitoring on April 28, 1988 revealed that three observation wells at boreholes 3, 8 and 12 were dry. These wells were installed to the bottom of the boreholes after refusal was encountered. Subsequent monitoring on June 1, 1988 found only two dry observation wells, at boreholes 3 and 8. Monitoring results are summarized on Table 2.

Groundwater levels varied slightly between monitoring events. Groundwater elevations are shown on Figure 12, although distribution of water levels on a relatively small site makes plotting of water table surfaces extremely unreliable. The measured elevations appear to indicate a general flow toward the west, inconsistent with the expected groundwater flow to the southeast, toward the creek. The unusual apparent groundwater flow pattern may be due to the influences of granular-filled trenches associated with the numerous buried services or of the undulating bedrock surface. Although the known inverts of current storm sewers are above the groundwater elevation, the southeast trending sanitary sewer is at approximately the same elevation as the water table, and abandoned pipes and trenches may be below the water table.

Water Chemistry

Samples of unfiltered monitoring well liquids were collected for analysis from boreholes BH1 and BH7. The analyses show that these samples contained significant concentrations of PAH's in excess of their aqueous solubility (Table 3), indicating the presence of a film of hydrocarbon on the groundwater surface. Extremely high values of aluminum, calcium, magnesium, and iron were also found in these samples (Appendix F). However, reference to

water quality guidelines for these parameters pertaining to the protection of aquatic species is not relevant because these samples do not represent the aqueous phase.

Low molecular weight PAH's (naphthalene through anthracene) were also found in analyses of the aqueous phase of the samples from BH1 and BH7 (Table 3). Sample BH1 (aqueous) contained 369 ppb naphthalene, while sample BH7 (aqueous) contained 169 ppb naphthalene. Table 4 compares chemistry of groundwater samples from Boreholes BH1 and BH7 with chemistry of soil samples from the same locations. The results show that PAH's are leaching from soils into the groundwater, at concentrations far below their solubilities.

Groundwater samples from boreholes BH5 and BH11 contain measurable but relatively low concentrations of PAH's ranging up to 5.4 ppb naphthalene at BH5, and up to 26.1 ppb pyrene at BH11. The presence of some high molecular weight PAH's at concentrations slightly exceeding their aqueous solubilities suggests that a minor hydrocarbon film may be present at these locations as well.

Groundwater at the site contains low concentrations of aqueous PAH contamination. Because the local groundwater is not used as a drinking water source, health effects through ingestion of contaminated groundwater on the site are not expected to occur. All developments in the vicinity of the site receive municipal water supply from the City of Brockville.

4.2.3 Storm Sewers

Samples of water and sediment from the only accessible manhole on the site did not contain visible or olfactory evidence of coal tar contamination. However, trace concentrations of PAH's and pyrene were detected in the sediment sample (Table 5). According to the City of Brockville Engineering Department, piping leading into and out of the manhole tested is constructed of PVC, and is therefore unlikely to be broken or cracked, to allow contaminated sediment or groundwater to enter the sewer system. The source of the trace contamination found in the storm sewer sediment is not known, however, it may result from adsorption of contaminants onto sediment particles in runoff from the asphalt parking lot surface, prior to entering the sewer system.

4.2.4 Stream Quality

Stream water samples were not visibly contaminated and had no odour, but when stream sediments were disturbed during sample collection, an oily sheen developed on the water surface as material was released from sediment. The sediment released an oily odour rather than a coal tar odour, which was present in all samples, including the upstream sample. Chemical analyses conducted on three sediment samples labelled STSS1, STSS2, and STSS3, collected at locations shown on Figure 7, indicate the presence of trace amounts of PAH's (at or near the method detection limits) in all samples. It should be noted however, that the specific PAH's reported varied between samples. These samples were collected from the upper 0.05 m of sediment, at the south edge of the creek, due to high spring water conditions. The variability in the PAH species detected is to be expected where concentrations are very low. A fourth sediment sample, labelled Sediment #1, collected from a depth of 0.2 m below the sediment surface, in the centre of the creek adjacent to the site, was found to contain measureable concentrations for all PAH compounds tested (Table 5).

Although aqueous phase groundwater samples from boreholes BH1 and BH7 contained mercury, arsenic, ammonia, and cyanide in concentrations exceeding the provincial water quality objectives for the protection of aquatic species, from "Water Management - Goals, Policies, and Implementation Procedures for the Ontario Ministry of the Environment (1978)", both upstream and downstream samples of water from Butler Creek indicate concentrations less than the criteria. PAH's were not detected in either the upstream or downstream samples (Appendix F).

The Ontario Ministry of the Environment reports that during a summer 1988 Scour Program inspection of Butler Creek in the vicinity of the former coal gasification plant site, coal tar wastes were observed in the bank and sediments of Butler Creek. West of the St. Paul Street bridge, tar was discovered at the north bank of the creek, after overturning several of the large stones reinforcing the bank. East of the St. Paul Street bridge, liquid tar derivatives bubbled up out of the sediment when disturbed. Subsequent chemical analysis, conducted by the MOE, confirmed that the materials were coal tar products.

PART 5 - CONCLUSIONS

Based on physical and chemical data collected during our site specific study of the former Brockville Coal Gasification Plant, the following conclusions were reached:

1. Coal tar residues are present on the site in both groundwater and soil on the former coal gasification plant site.

2. In view of the proximity of the site to Butler Creek, contaminated groundwater from the site may be discharging to the creek. However, the impact on the creek is negligible, as PAH's were not detected in stream waters (Appendix F).

3. Low molecular weight PAH's (naphthalene to anthracene) are present in sediments of Butler Creek adjacent to the former coal gasification plant site. However, PAH's were not detected in water samples collected upstream or downstream of the site.

4. No evidence of coal tar seepage from the former coal gasification plant site was observed along the stream bank during our study. However, it has been reported that visible coal tar was encountered during recent Scour Program activities on the north bank of the creek, west of St. Paul Street, and in the stream sediments at the south bank of the creek, east of St. Paul Street (MOE Kingston).

5. Geophysical evidence indicates that many of the foundations for structures associated with the former coal gasification plant are present on the site. The notable exception was the absence of high conductance material (ie. steel or reinforced concrete) in the vicinity of the former main gas holder. The base of the former main gas holder may have been removed when the plant was demolished. The presence of former structures could not be confirmed with the drilling program.

6. Analysis of sediments collected from service manholes on the site indicated trace quantities of PAH's, between 100 ppb to 700 ppb. This marginal contamination probably results from catchment of PAH contaminated sediment particles from the parking lot surface.

7. The presence of coal tar wastes below the parking lot area has no measureable effect on air quality in the vicinity of the site. No impact on air quality was detected during drilling activity.

PART 6 - RECOMMENDATIONS

On the basis of our study at the former Brockville Coal Gasification Plant site, the following recommendations are offered.

1. All inactive pipes protruding from the stream bank in the vicinity of the former coal gasification plant site should be permanently grouted to prevent any discharge from the site into the stream. None of the pipes display evidence of recent liquid flow.

2. Additional sampling of sediments should be undertaken at Butler Creek to determine the area and volume of coal tar contaminated sediments encountered during recent Scour Program activities. This information should be used to evaluate the extent of remediation required for the coal tar contaminated sediments.

3. If removal of tar from Butler Creek is undertaken, consideration should be given to contain the coal tar, and to prevent migration of liquid coal tar or contamination from the site.

4. Caution should be used in developing properties to the east of the site. Consideration should be given to conducting additional study prior to developing lands east of the site.

5. The presence of coal tar or coal tar related contamination should be registered on title.

TABLES

TABLE 1
AIR MONITORING RESULTS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

PHASE 1		
STATION		TIP 1 Measurement
Theatre		
1	basement, north end	-0.2
2	basement, south end	-0.7
3	basement, boiler room	-0.5
On Site		
4	front of theatre	0
5	east wall of theatre	0
6	center of empty lot, east of site UPWIND	0
7	creek, adjacent to Sheppard Grist Mill	0
8	bridge	0
9	south wall of theatre	0.1
10	waste compactor	0.1
11	sanitary sewer grate	0.1
12	gas meter	0.1
13	loading docks	0.1
14	IGA building, south west corner	0.1
15	IGA Entrance	0.1
16	middle of west parking lot	0
17	bridge on King St.	0
18	lamp posts along creek	0
19	gas metering station	0.2
20	south of bridge on St. Paul	0
	Pipes protruding from retaining wall	
	- beyond 7 meters fror the bridge	0
	- within 7 meters of the bridge	0.2 to 0.7

* TIP 1 (total Ionization Potential)
- Unit calibrated for isobutylene
- unit calibrated in background air UPWIND of the site.

TABLE 2
WATER MONITORING RESULTS
BROCKVILLE COAL GASIFICATION SITE.
MINISTRY OF THE ENVIRONMENT

BOREHOLE	ELEVATION meters	WATER ELEVATION (meters) 4/28/88	6/1/88
1	80.860	76.398	76.42
2	80.797	-	-
3	80.469	dry	dry
4	80.227	-	-
5	79.981	75.768	75.871
6	79.683	-	-
7	79.872	76.536	76.762
8	80.077	dry	dry
9	79.993	-	-
10	79.805	-	-
11	80.167	75.399	75.242
12	80.172	dry	75.422

NOTE
Base of Borehole 3 is at 77.427 m
Base of Borehole 8 is at 76.435 m
Base of Borehole 12 is at 75.325 m
- no monitoring well installed

TABLE 3
GROUNDWATER AND MULTIPHASE QUALITY
BROCKVILLE COAL GASIFICATION SITE.
MINISTRY OF THE ENVIRONMENT

	Aqueous Solubility*	Borehole 1		Borehole 5	Borehole 7		Borehole 11
		Multi-	Aqueous		Multi-	Aqueous	
Naphthalene	34400	6,034	369	5.39	9,995	169	2.54
Acenaphthylene	3930	3,733	--	1.60	2,896	26.2	9.31
Acenaphthene	3420	221	--	0.48	1,362	26.5	1.24
9H Fluorene	1980	840	14.7	0.57	1,502	17.2	3.30
Phenanthrene	1290	2,008	17.7	1.50	3,515	12.1	11.28
Anthracene	73	936	--	0.64	1,630	3.7	5.00
Fluoranthene	260	930	--	1.72	2,111	--	23.08
Pyrene	140	1,261	--	2.85	2,507	--	26.13
Chrysene	2	493	--	1.72	1,497	--	14.04
Benzo(a)anthracene	14	632	--	1.83	1,673	--	14.25
Benzo(b)fluoranthene	n/a	370	--	1.35	1,053	--	15.92
Benzo(k)fluoranthene	n/a	540	--	1.59	1,315	--	12.98
Benzo(a)pyrene	3.8	531	--	1.45	1,956	--	16.60
Perylene		--	--		--	--	
Indeno(123-cd)pyrene	n/a	159	--	1.00	1,115	--	12.76
Dibenzo(ah)anthracene	0.5	51	--	0.38	231	--	3.79
Benzo(ghi)perylene	0.26	159	--	0.85	1,294	--	10.49

NOTE: All values are listed in ppb (parts per billion)
-- denotes parameter not detected
n/a denotes not available
* Data from EPA Treatability Manual (EPA-600/8-80-042a)

TABLE 4
SOIL QUALITY VS GROUNDWATER QUALITY
BROCKVILLE COAL GASIFICATION SITE.
MINISTRY OF THE ENVIRONMENT

	Aqueous Solubility*	Borehole 1		Borehole 7	
		Soils	Groundwater	Soils	Groundwater
Naphthalene	34400	2,800	369	7,000,000	169
Acenaphthylene	3930	2,500	--	633,000	26.2
Acenaphthene	3420	400	--	1,120,000	26.5
9H Fluorene	1980	1,400	14.7	1,150,000	17.2
Phenanthrene	1290	3,000	17.7	3,130,000	12.1
Anthracene	73	1,300	--	775,000	3.7
Fluoranthene	260	2,500	--	1,050,000	--
Pyrene	140	8,000	--	1,320,000	--
Chrysene	2	1,900	--	446,000	--
Benzo(a)anthracene	14	2,300	--	380,000	--
Benzo(b)fluoranthene	n/a	2,900	--	519,000	--
Benzo(k)fluoranthene	n/a	**	--	**	--
Benzo(a)pyrene	3.8	3,900	--	382,000	--
Perylene		600	--	tr	--
Indeno(123-cd)pyrene	n/a	1,500	--	tr	--
Dibenzo(ah)anthracene	0.5	3,800	--	tr	--
Benzo(ghi)perylene	0.26	900	--	tr	--

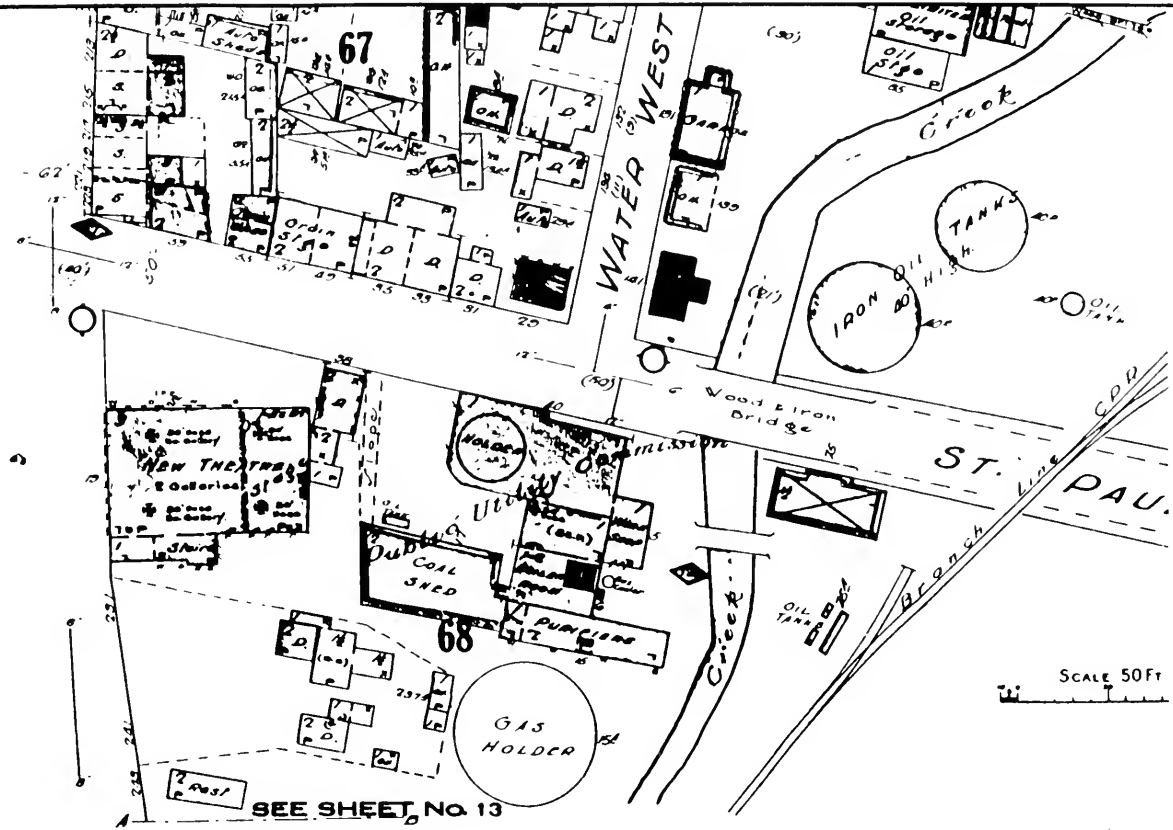
NOTE: All values are listed in ppb (parts per billion)
-- denotes parameter not detected
n/a denotes not available
* Data from EPA Treatability Manual (EPA-600/8-80-042a)
** Analyses for Benzo(b)fluoranthene and Benzo(k)fluoranthene are combined.

TABLE 5
STORM SEWER SEDIMENT AND STREAM SEDIMENT QUALITY
BROCKVILLE COAL GASIFICATION SITE.
MINISTRY OF THE ENVIRONMENT

	Storm Sewer Sediment	Stream Sediment			
	(SSS)	(STSS 1)	(STSS 2)	(STSS 3)	Sediment 1
Dichloromethane	--	--	trace	trace	
Toluene	5.54	67.32	--	--	
Naphthalene	--	--	--	--	3330
Acenaphthylene	--	--	200	--	7800
Acenaphthene	--	--	--	trace	110000
9H Fluorene	--	--	--	40	57400
Phenanthrene	trace	trace	trace	200	137000
Anthracene	--	--	trace	50	45500
Fluoranthene	trace	200	trace	400	49500
Pyrene	trace	200	trace	400	69700
Chrysene	trace	trace	trace	trace	33900
Benzo(a)anthracene	trace	trace	trace	trace	35300
Benzo(b)fluoranthene	trace	600	trace	trace	30600
Benzo(k)fluoranthene	*	*	*	*	*
Benzo(a)pyrene	trace	trace	trace	trace	19800
Perylene	--			--	1910
Indeno(123-cd)pyrene	--	trace	trace	trace	9400
Dibenzo(ah)anthracene	--			--	1630
Benzo(ghi)perylene	--	trace	trace	trace	1790

NOTE: All values are listed in ppb (parts per billion)
-- denotes parameter not detected
* Analyses for Benzo(b)fluoranthene and Benzo(k)fluoranthene are combined.

FIGURES



NOTE

1931 Plan of Brockville Coal Gasification Plant, Source, Fire Insurance Plan, Public Archives Canada, NMC-9327, 7/17

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

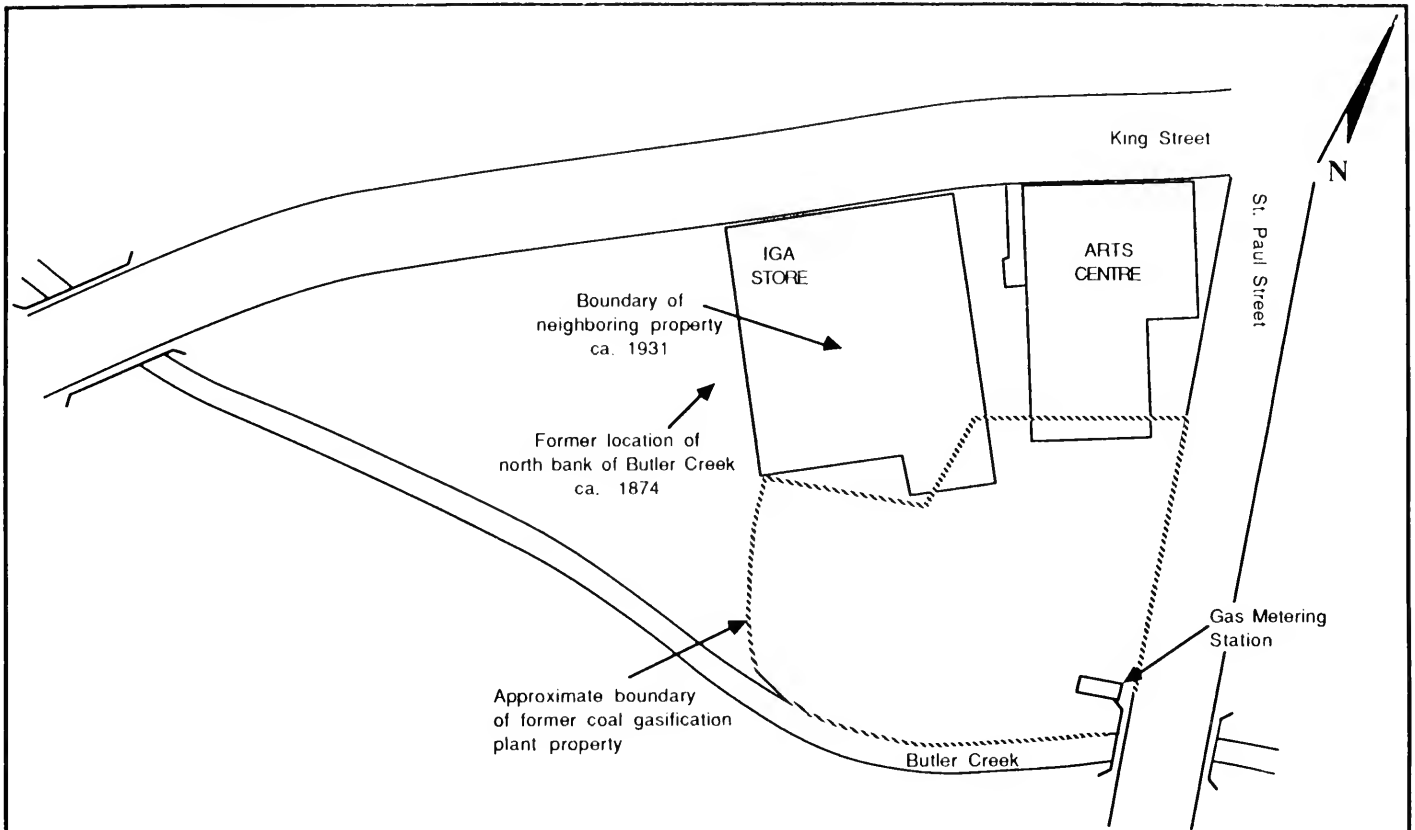
1931 PLAN OF SITE

Proj. No. 10044-003

Scale:

Date: 06-28-88

FIGURE 1



NOTE:

Location of the former Coal Gasification Plant
from the Fire Insurance Plan, Public Archives Canada,
NMC-327, 7/17

Locations of the existing buildings from the Ministry of Natural
Resources Air Photographs

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

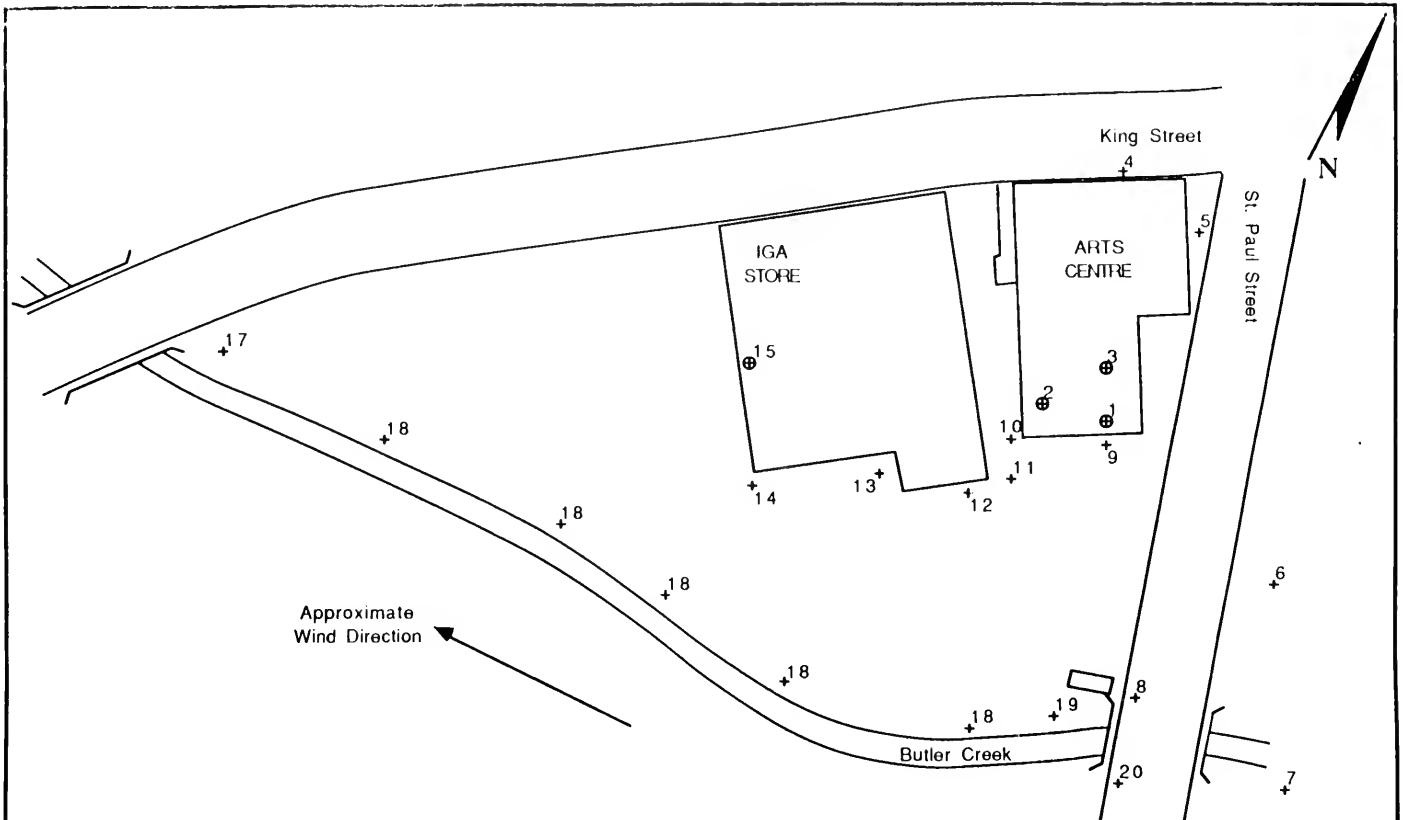
GENERAL SITE PLAN

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE 2



LEGEND

+ Air quality monitoring stations

⊕ Interior monitoring locations

Locations described in Table 3

NOTES

1. Phase 1 air monitoring conducted to evaluate the background air quality prior to beginning of drilling program.

2. Instrument was zeroed at station 6.

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

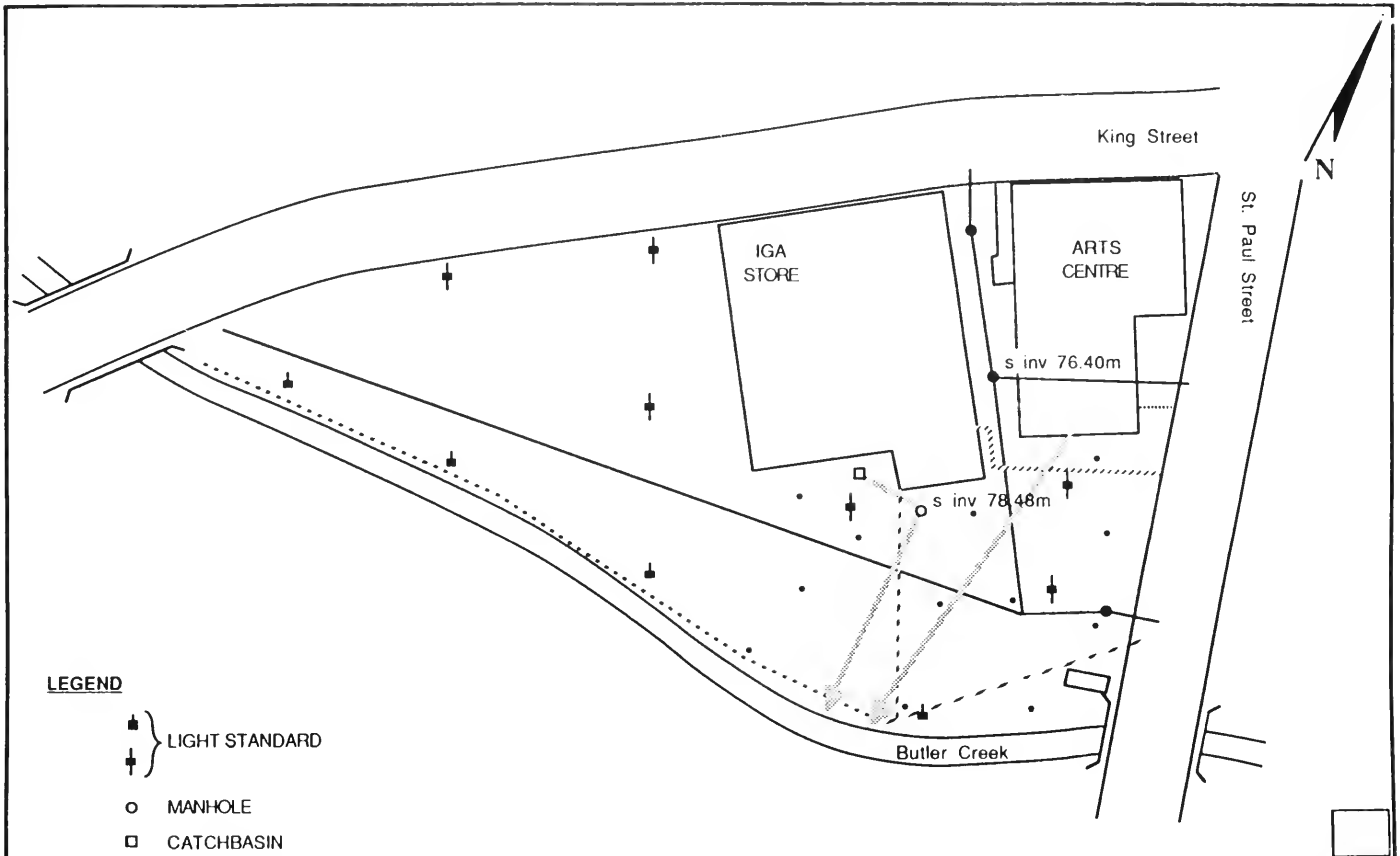
AIR MONITORING STATIONS

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE 3



TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

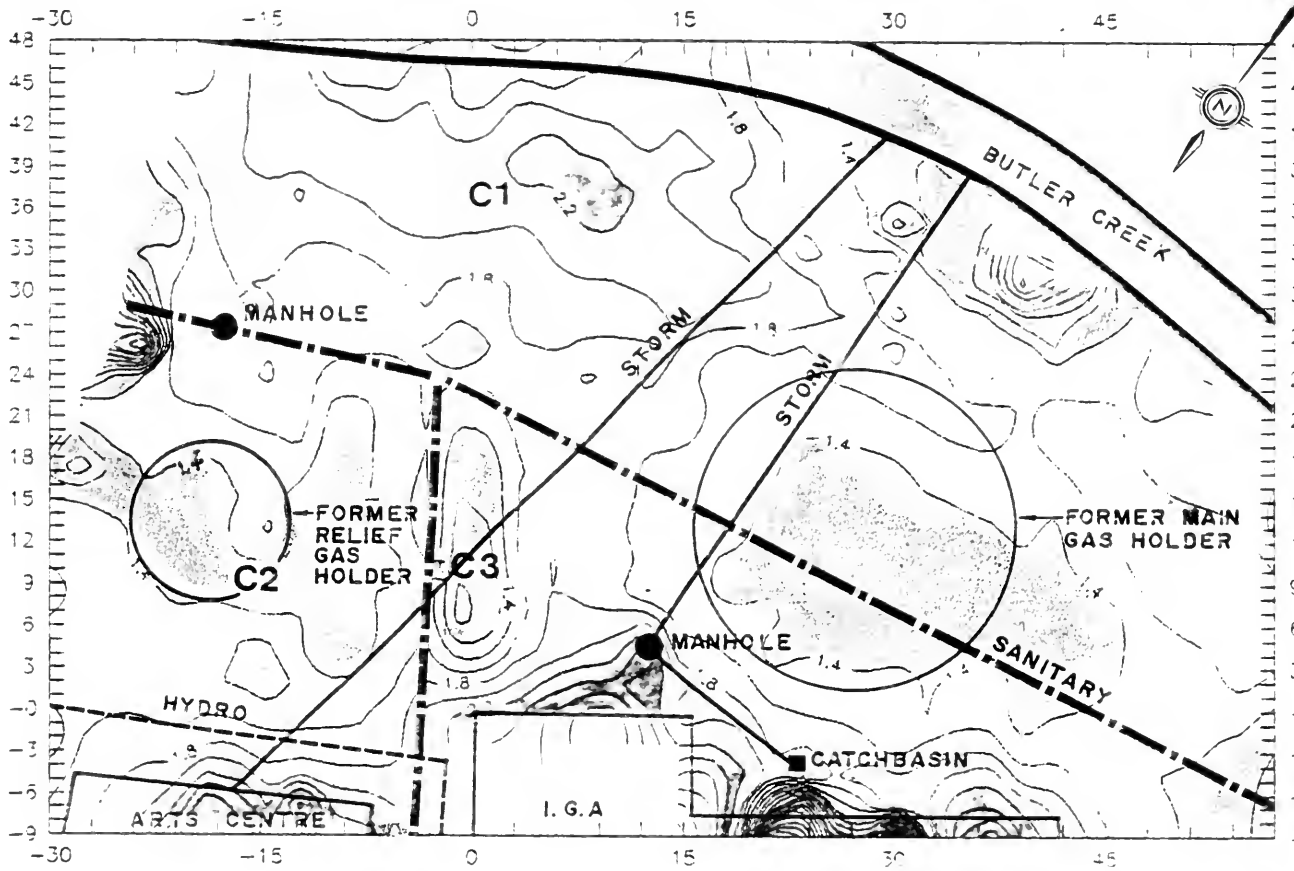
BURIED SERVICE LOCATIONS

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE 4



NOTE:

After Figure 2 of Hyd-Eng Geophysics Inc. report dated April 1988. (see Appendix A)

Hyd-Eng GEOPHYSICS INC.

TROW, DAMES & MOORE

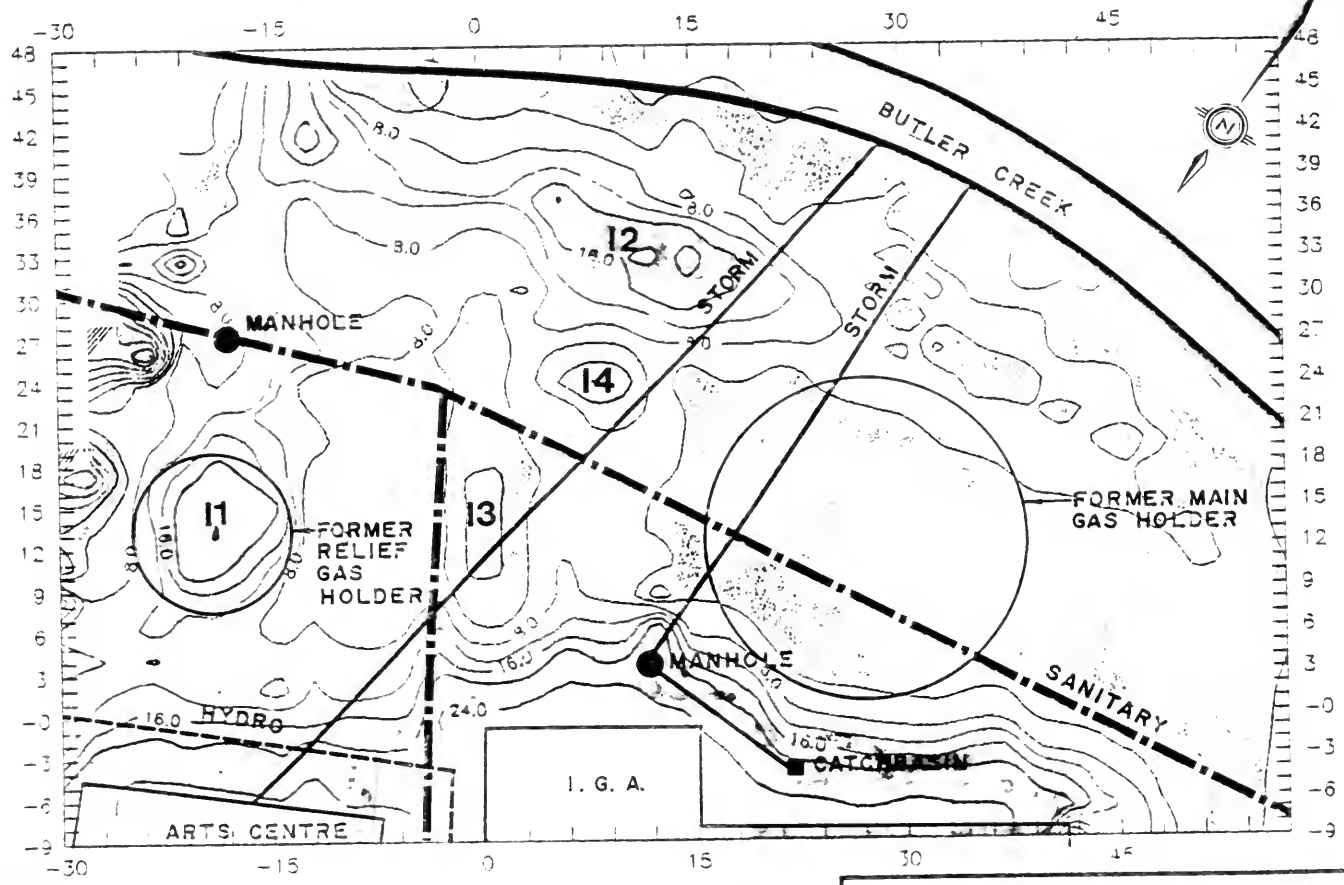
ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

GROUND CONDUCTIVITY

Proj. No.	10044-003
Scale:	1:400
Date:	06-28-88

FIGURE 5



NOTE:

After Figure 3 of Hyd-Eng Geophysics Inc. report dated April 1988. (see Appendix A)

Hyd-Eng GEOPHYSICS INC.

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

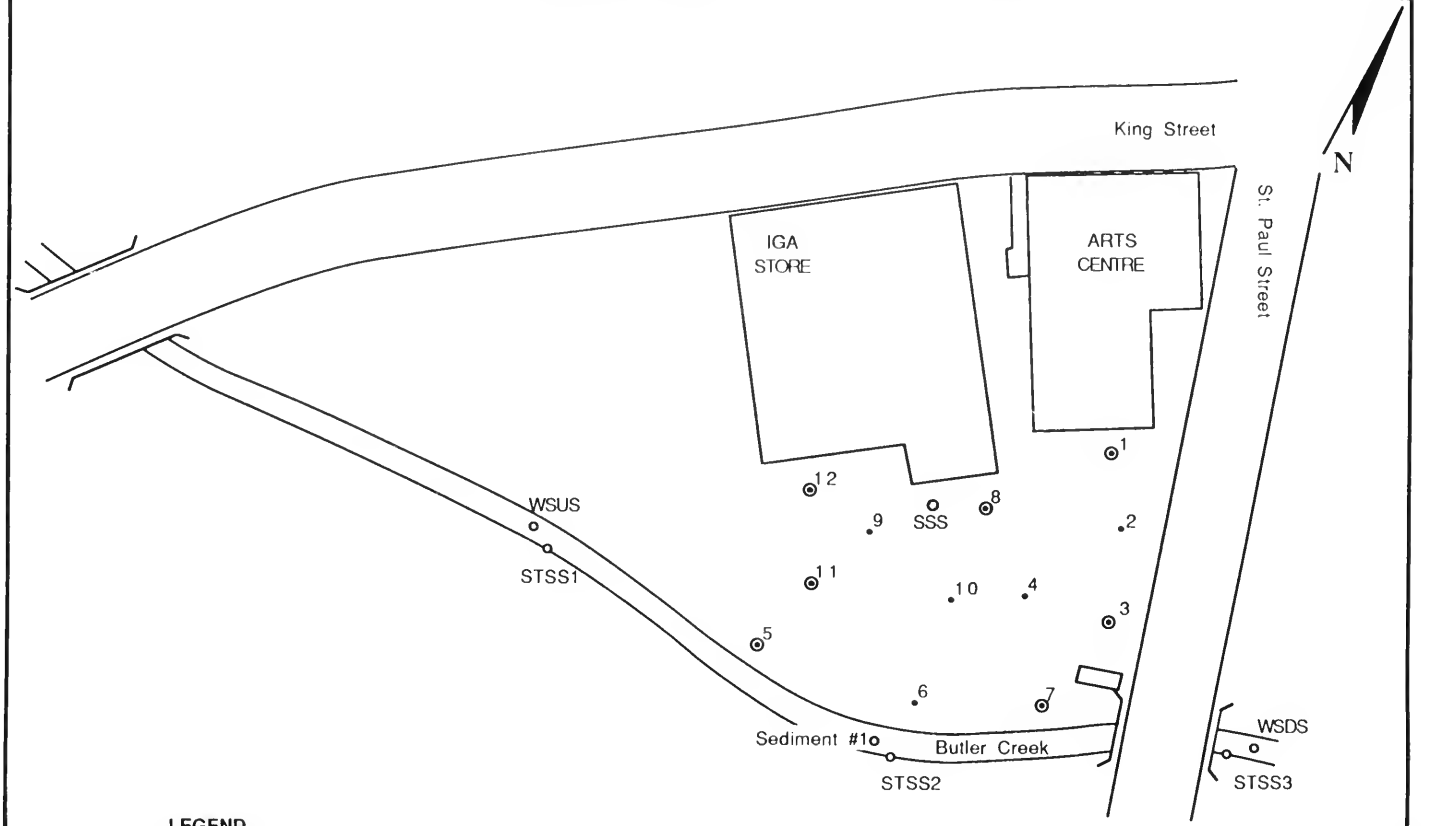
INPHASE GROUND CONDUCTIVITY

Proj. No. 10044-003

Scale: 1:400

Date: 06-29-88

FIGURE 6



LEGEND

- • Borehole
- ⊙ Borehole with standpipe installation
- o Stream sediment or water sampling locations
- o Storm Sewer Manhole

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

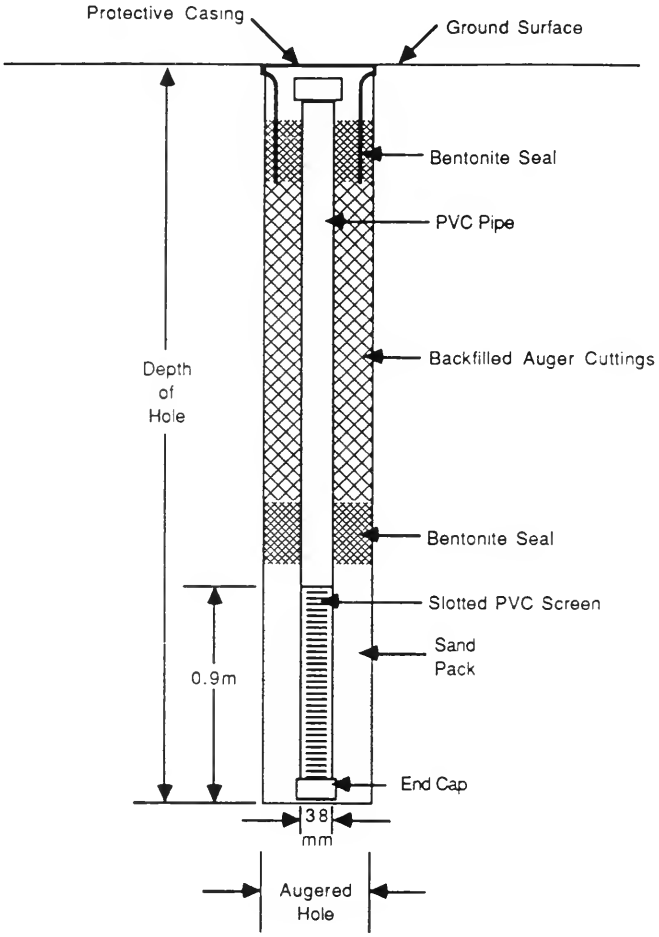
BOREHOLE LOCATIONS

Proj. No. 10044-003

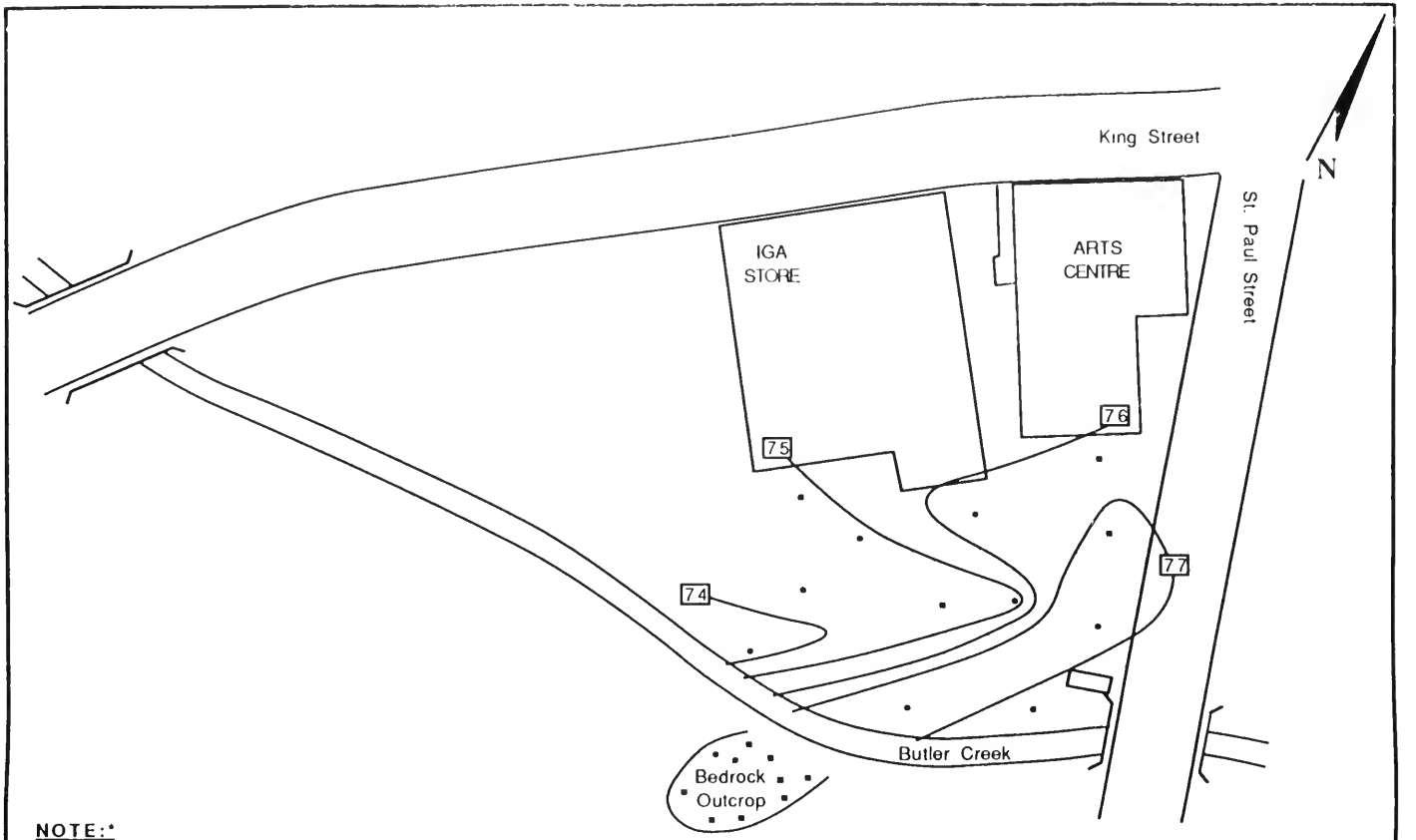
Scale: ~1:1000

Date: 06-28-88

FIGURE 7



TROW, DAMES & MOORE	
ONTARIO MINISTRY OF THE ENVIRONMENT Brockville Coal Gasification Plant TYPICAL OBSERVATION WELL INSTALLATION	Proj. No. 10044-003 Scale: N.T.S. Date: 06-28-88 FIGURE 8



NOTE:*

1. The elevations shown are based on refusal in eight boreholes (see Appendix C). Refusal may be caused by bedrock or by other solid objects such as buried concrete foundations.

2. Elevations shown are in meters above mean sea level.

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

INTERPRETED BEDROCK SURFACE CONTOURS*

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE 9

LEGEND

- coal tar odour in soil samples
- coal tar visible in soil samples
- coal tar found immediately above assumed bedrock

NOTE

Cross Section A-A' is shown on Figure 11

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

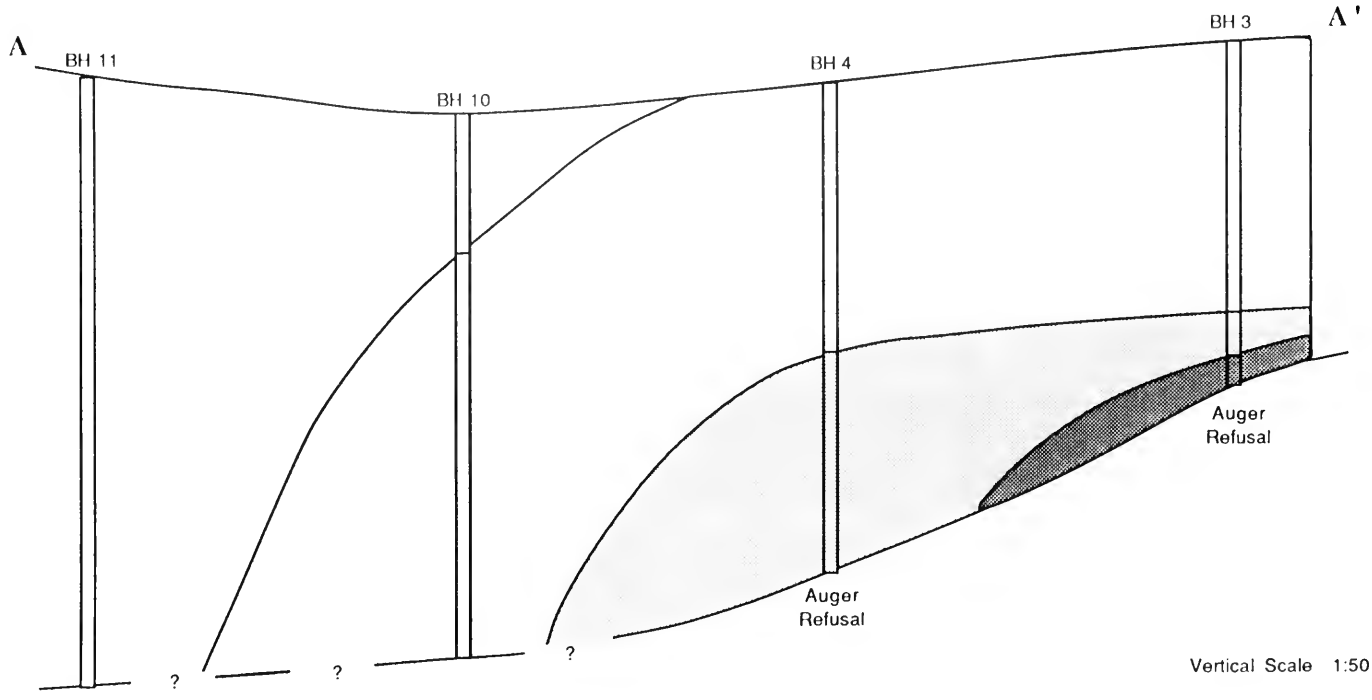
ESTIMATED EXTENT OF CONTAMINATION

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE10



LEGEND

- coal tar odour in soil samples
- coal tar visible in soil samples
- coal tar found immediately above assumed bedrock

NOTE

Line of Cross Section A-A' is shown on Figure 10.

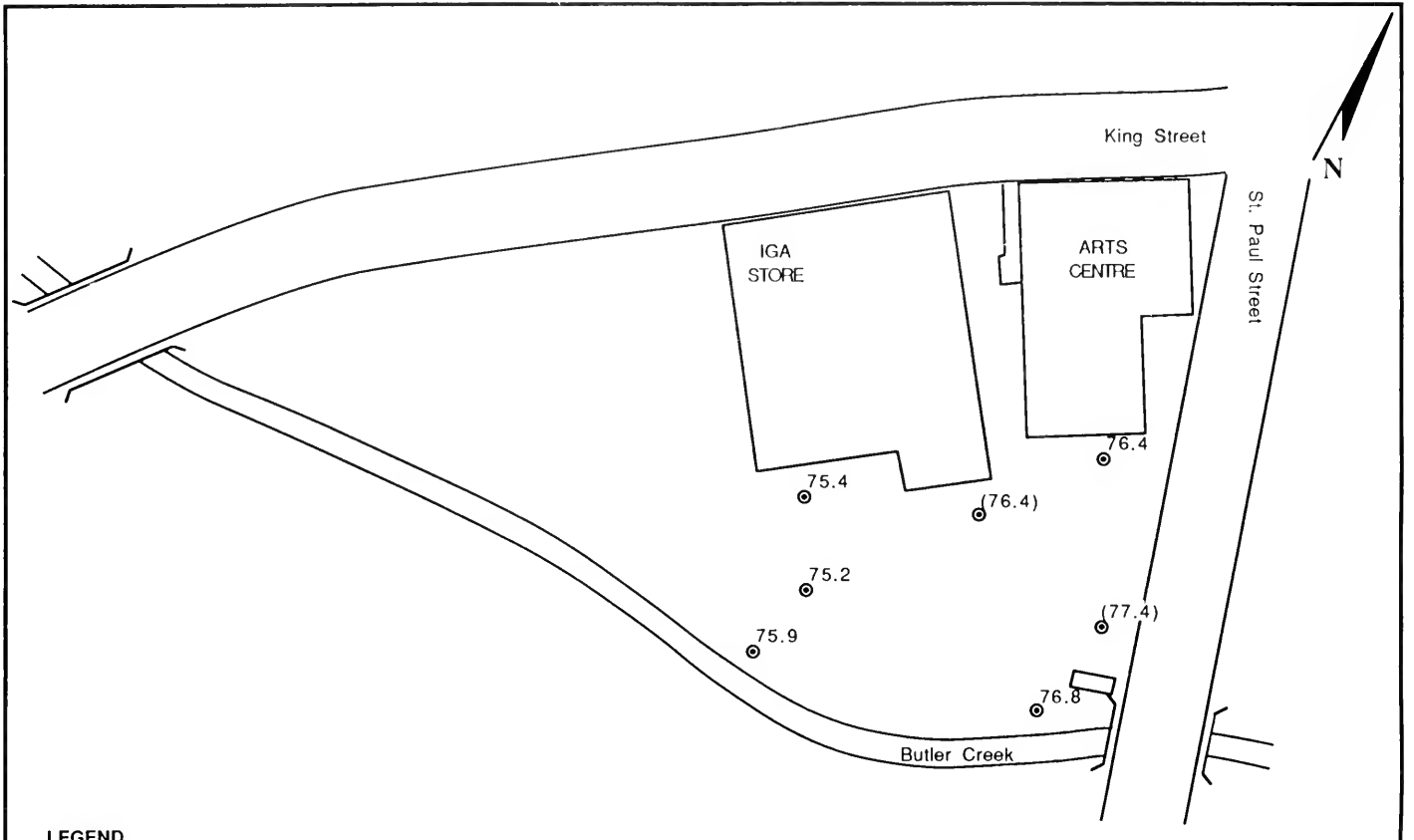
TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant
SCHEMATIC CROSS SECTION
OF CONTAMINANT CLASSES

Proj. No. 10044-003
Scale: N.T.S.
Date: 06-28-88

FIGURE 11



LEGEND

75.9 — Observation well locations and water level elevations (June 1, 1988) - Numbers in brackets indicate the bottom elevation of dry wells.

75.5 — Contour of groundwater table surface and contour elevation (meters above mean sea level)

TROW, DAMES & MOORE

ONTARIO MINISTRY OF THE ENVIRONMENT

Brockville Coal Gasification Plant

WATER LEVEL ELEVATIONS

Proj. No. 10044-003

Scale: ~1:1000

Date: 06-28-88

FIGURE 12

APPENDIX A

AIR QUALITY CRITERIA

APPENDIX A

AIR QUALITY CRITERIA [1)]

Hydrocarbon Compound	Concentration in ng/m^3 Averaged Over 0.5 Hours	Limiting Effect, Type of Standard
Benzo(a)pyrene	3.3	Health, Provisional Guideline at Point of Impingement Single Source
Benzene	10,000	Health, Standard at Point of Impingement
Toluene	2,000	Odour, Standard
Xylene	2,300	Odour, Standard
Naphthalene	36	Health, Provisional Guideline

1) Air Resources Branch, MOE as of 87-05-26.

APPENDIX B

HYDROCHEMISTRY PARAMETERS

APPENDIX B

HYDROCHEMISTRY PARAMETERS

pH

Calcium
Magnesium
Sodium
Potassium
ICAP Trace Metals

Alkalinity
Bicarbonate
Sulphate
Sulphide
Chloride
Cyanide
Ammonium
TKN
COD
TOC
Phenols

Volatiles:

Benzene
Toluene
Xylene

PAH's
including
Naphthalene
Benzo(a)Pyrene

APPENDIX C

HYD-ENG GEOPHYSICS LTD. REPORT

EM31 Survey at the Brockville Coal gasification Plant

by Hyd-Eng Geophysics Inc.

for

Trow Dames & Moore

April 1988.

Hyd-Eng GEOPHYSICS INC.

#712 33 Weldrick Rd. E., Richmond Hill, Ont., L4C 3W4 416-737-5918

Mr. K. Chorel,
Trow Dames & Moore,
1595 Clark Boulevard,
Brampton, Ontario.
L6T 4V1

March 3, 1988

Dear Ken,

This reports the results of the EM31 survey you commissioned at the former coal degasification plant in Brockville Ontario. The field work was completed on the 28th and 29th of March.

The EM 31 measures conductivity of the earth by monitoring the distortion of an electromagnetic field caused by the ground. The units of measurement are millimhos per metre. The instrument also measures the inphase component of the distorted electric and magnetic fields. The inphase component is particularly sensitive to metal content in the ground. Both modes of operation were used in this survey. Data were collect directly onto a data collection instrument and later transferred to floppy disk.

A grid was set over the area of primary interest (see Figure 1). The south-east corner of the IGA store was designated the

origin and lines (3 metres apart) were surveyed north-south parallel to an extension of the east wall of the store. Stations were paced along the lines. Three additional lines west of the main grid were used for reconnaissance.

Figure 2 shows the log of the conductivity readings. The northern quarter of the plot is dominated by the influence of present buildings The southern part of the grid has a large east-west trending high (C1) that is likely related to previous use of the land. The green low (C2) along the eastern part of the grid probably indicates the limits of former buildings. Another low (C3) is elongate and likely to be either a pipe, or utility.

Figure 3 is the inphase results. Again the northern part of the plot is dominated by existing buildings. Of particular interest are two strong high anomalies I1 and I2. I1 is circular in nature and may represent the location of a former tank or re-enforced foundation. I2 approximately fits the expected southern limit of the former structure. It is an elongate anomaly, running along most of the southern limit of the grid. The two southeastern small highs are related to surface structures. A north-south trending low I3 along Line 0 corresponds to C3 discussed above. Another circular anomaly I4 stands on its own and is presently unexplainable.

The results along three lines that extend beyond the main grid are shown on Figure 4. These show nothing note worthy to the west of the IGA store. The only anomalies present are related to

manholes in the parking lot

I hope these results meet your expectations. If you have any questions please do not hesitate to call.

Sincerely,

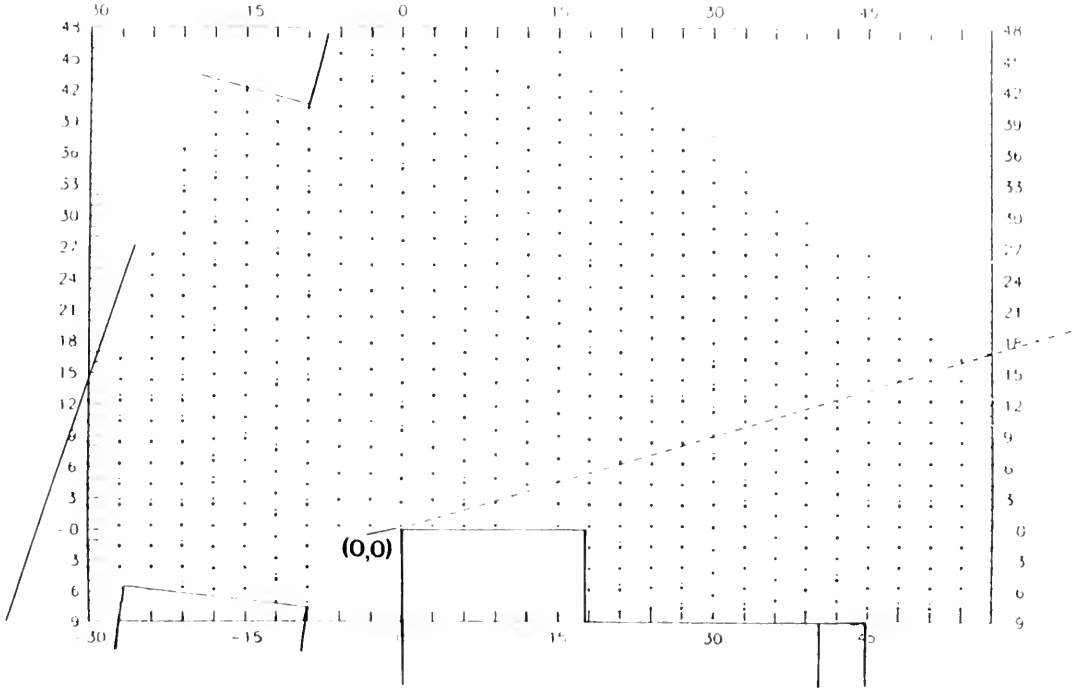
P. Pehme Pres.
per Hyd-Eng Geophysics Inc.

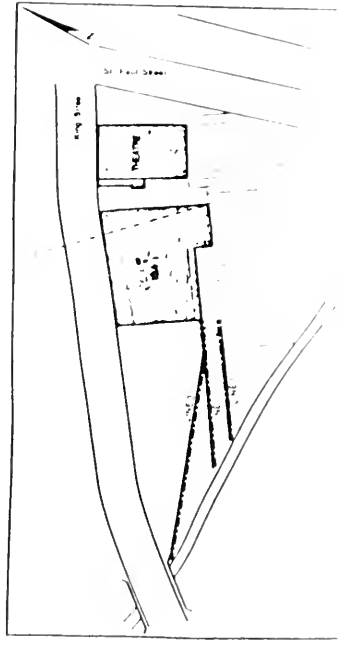
Figure 1 EM 31 Base Map

BROCKVILLE COAL GASIFICATION PLANT

Hyd-Eng GEOPHYSI INC.

1:400





1:400

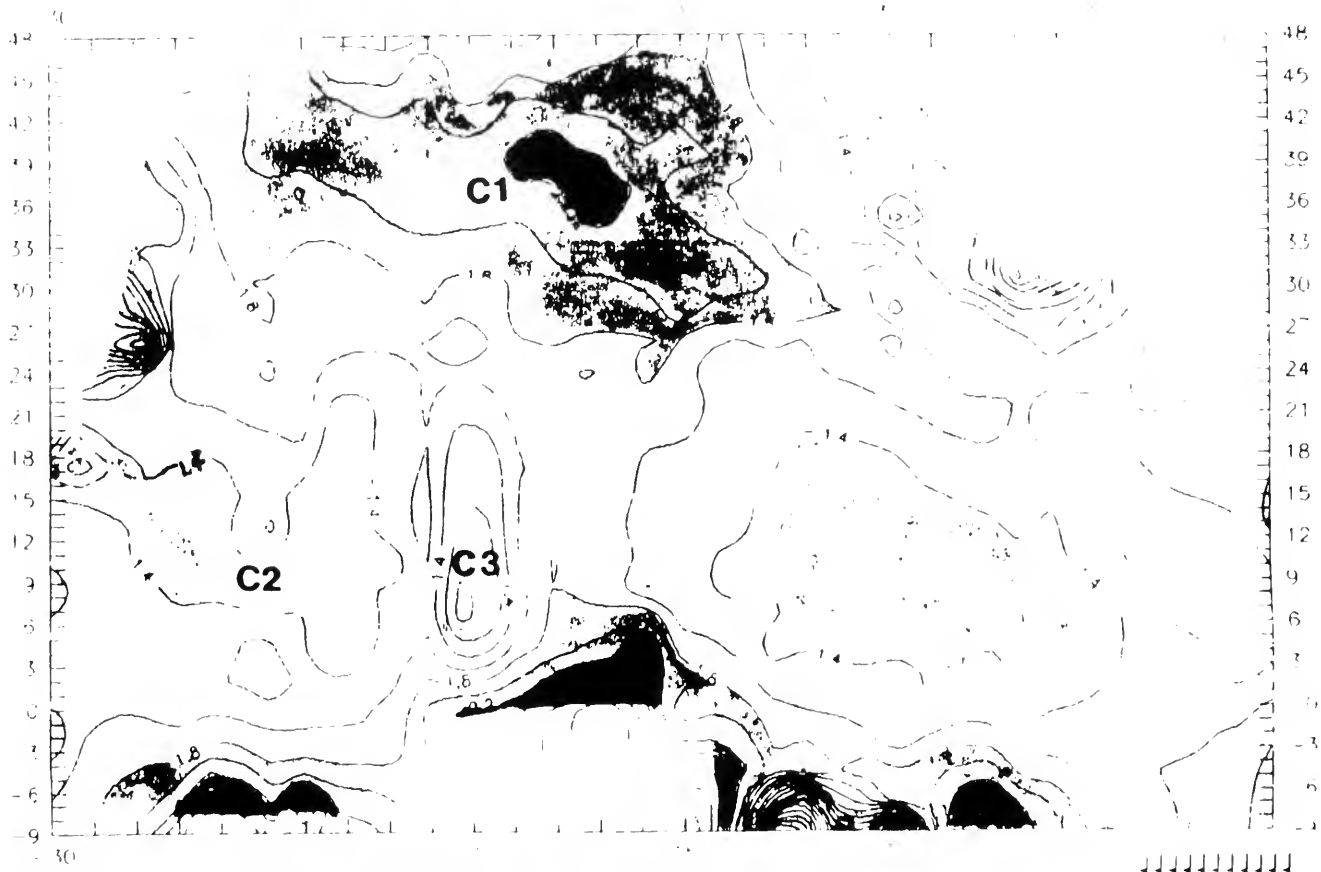


Figure 2 BROCKVILLE COAL GASIFICATION PLANT (Log Cond.)

Hyd-Eng GEOPHYSICS INC.

1:400

Figure 3 BROCKVILLE COAL GASIFICATION PLANT (Inphase)

Hyd-Eng GEOPHYSICS INC

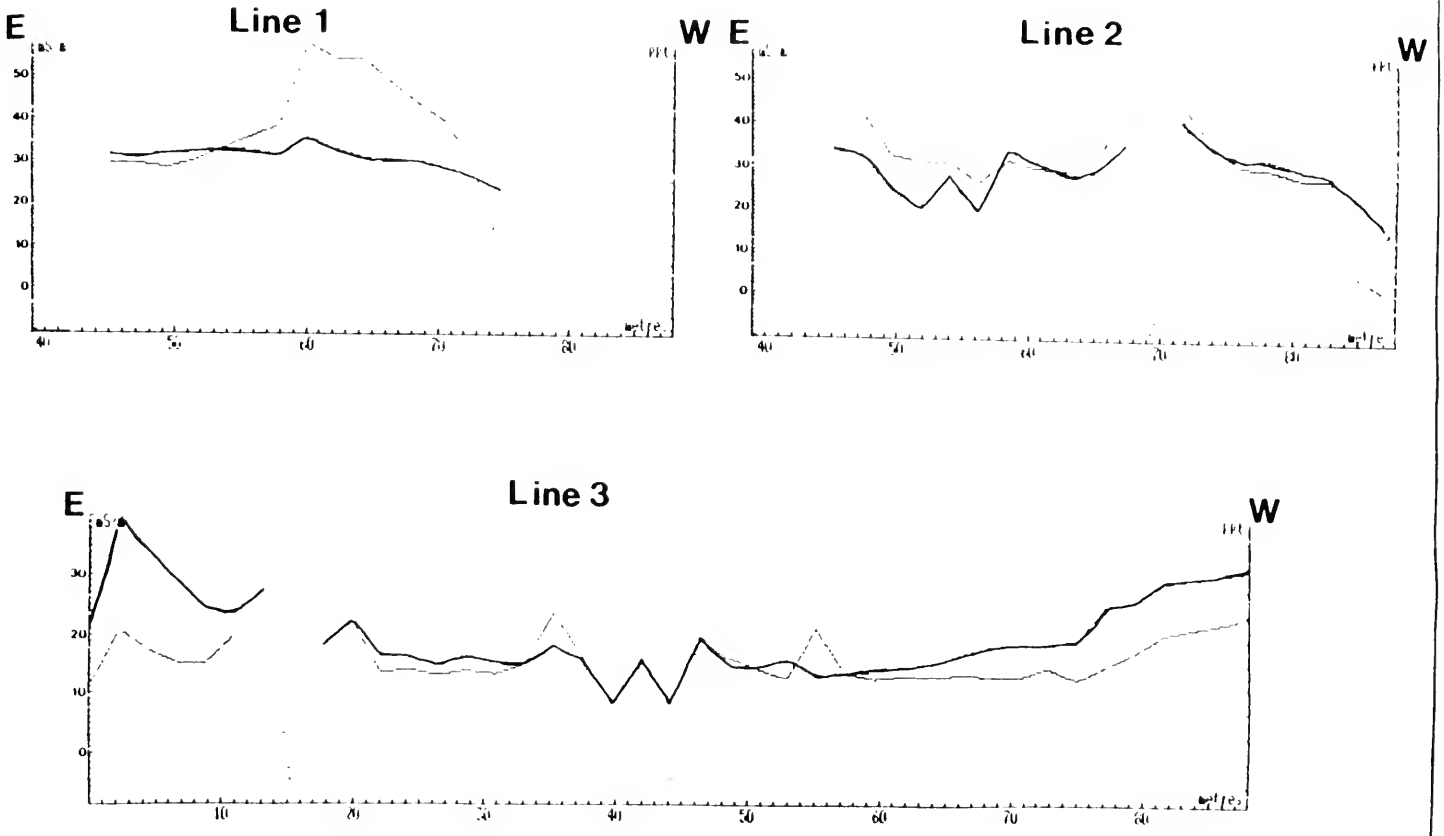


Figure 4 EXTRA LINES

APPENDIX D

BACKGROUND SITE INFORMATION

from

Inventory of Coal Gasification Plant
Waste Sites in Ontario
Volumes I and II
Intera, 1987

4.3.5 Brockville

Site Description

The Brockville Gas Company, was located on the west side of St. Paul Street between King Street West and Butler Creek and was in operation for about 104 years from 1853 to 1957. After 1921, the gas plant was operated by the Brockville Public Utilities Commission. The gas plant was of medium size, occupying about 0.5 ha and was probably a coal carbonization plant initially, but was likely converted to water gas in the early 1900's.

The former gas plant property is now occupied by a City of Brockville parking lot for the adjacent Arts Centre Theatre and IGA supermarket. Commercial buildings are located to the north, west and east with residential areas located to the east and south. Butler Creek which flows to the St. Lawrence River lies immediately to the south of the former site. The parking lot is paved and effectively covers and drains the site.

Potential Environmental Impact

The Brockville gas works has had no reported environmental problems and the site inspection, although hindered by winter conditions, did not detect odours or visible contamination. Shallow excavation into the site in 1985 for the city parking lot did not reportedly encounter waste materials. A 1200 mm diameter sanitary trunk sewer also extends through the site with no reported problems.

Although there are no apparent environmental problems associated with the site, the years of plant operation are long, (104 years) increasing the likelihood of having produced a large amount of waste. The site has been excavated (sewer construction) which may

have disturbed any existing waste containment structures. There is also no information to indicate that waste facilities were removed from the property. The adjacent creek is likely to be the receptor for any contaminant releases to the environment. At present, storm catch basins for the parking lot drain into the creek from the creek bank. In addition, the creek is at an elevation approximately 5 m below the parking lot surface creating a significant gradient for coal tar migration.

Options for Further Action

For the Brockville site, the following are considered to be appropriate options for further actions:

- Notify present property owners and municipality that buried gas plant wastes may be found on-site;
- Sediment sampling of Butler creek adjacent to the former gas plant and analysis for PAH contaminants.

Fact Sheet for Survey of Coal Gasification Plant Waste Sites

1. **Site Location:**

City Brockville Street Address 40 St. Paul Street bounded by St. Paul/King St. W/Butlers Creek

MOE Region Southeastern

MOE District Kingston NTS Map Sheet 31 B/12

Historical Maps Available 1875 - Bird's Eye View, Blow Up (Public Archives Canada, NMC 11 (5031); 1917 - Revision of 1911 Fire Insurance Plan (Regional Collection, University of Western Ontario), Sheet 7; 1931 - Revisions of 1912 Fire Insurance Plan (PAC, NMC 9327, 7/17); 1946 - Revisions of 1931 Fire Insurance Plan (PAC, NMC 9328

2. **Site Identification:**

Name Brockville Gas Works

Type of Facility Coal carbonization then water gas

Operator(s) and Period(s) of Operation Brockville Gas Works 1853-1921

Brockville Public Utilities Commission 1921-1957

3. **Site Characteristics:**

Size (when operated) Small, 0.5 ha

Present Land Use Commercial

Planned Land Use As is

Present Occupant(s) City owned parking lot for Arts Centre and IGA

Present Land Use Adjoining Properties N-commerical W-commerical S-residential E-residential

Underground Utilities Sanitary sewer and water mains in parking lot, small diameter storm sewers to creek

Soil Conditions Unknown, fill assumed

Site Access Uncontrolled access

4. **Evidence of Buried Wastes:**

Operating Period 1853 to 1957 (104 years)

Excavation History Sanitary sewers and water mains through parking lot and storm drains to creek

Visible Wastes None reported or observed

Odour None reported or observed

Water Pollution None reported or obaserved

5. **Resource Characteristics:**

Surface Water Butler Creek adjacent to site (flows to St. Lawrence River

Proximity Adjacent to site

Use Recreational

Groundwater, Proximity Unknown

Use Unknown (unlikely to be used)

Proximity of Existing Wells None reported in impact area

Site Investigations Shallow excavations during parking lot construction

6. **Comments/Remarks:** Excavation through site but no wastes reported: 5 m gradient creek

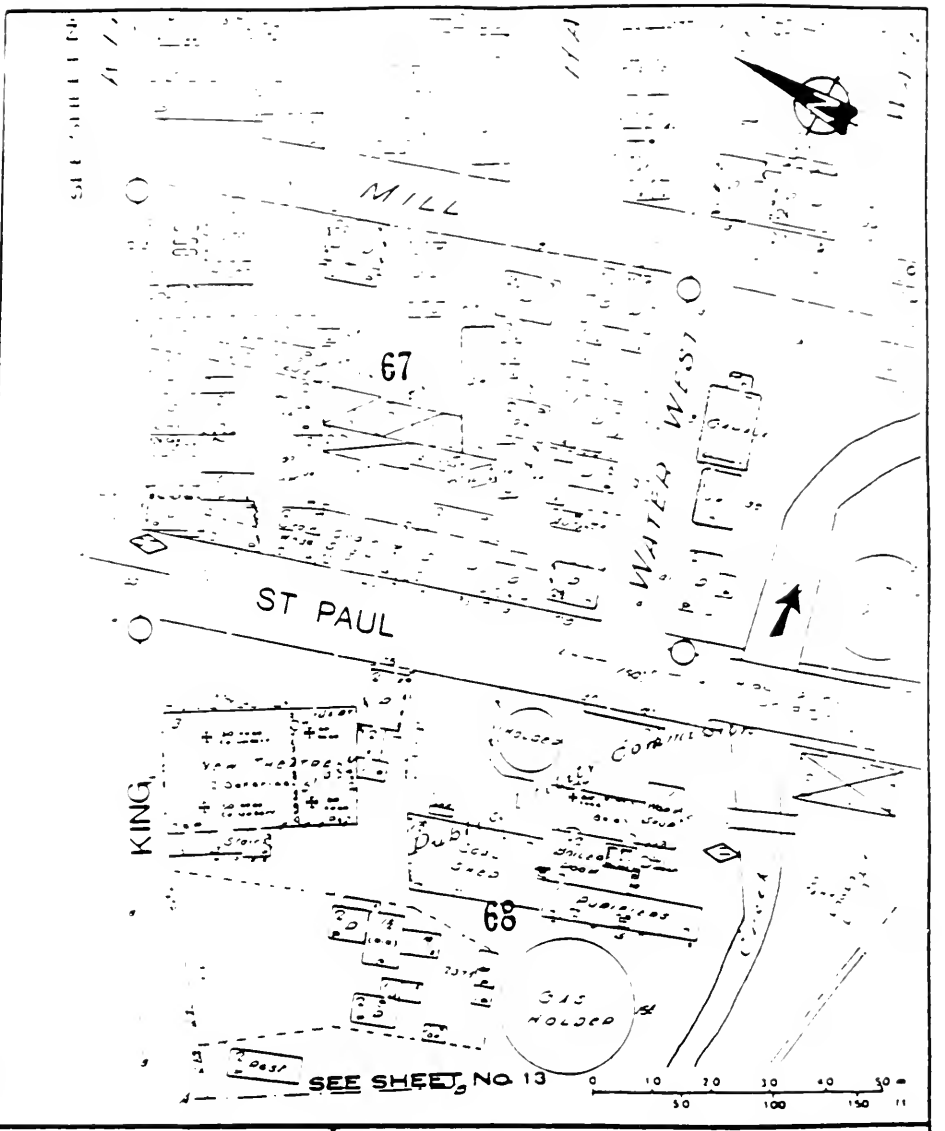
7. **Off-Site Disposal Areas:** Possibly Old Chemical Road Landfill

INTER

Drawn by	Date
Checked by	Date
Revisions	Date

City of Brockville, showing location of former gas works.

INTERA Technologies



Drawn by	Date
Checked by	Date
Revisions	Date

1931 Plan of Brockville Gas Works, (Source: Fire insurance plan, Public Archives Canada, NMC-9327, 7/17)

INTERA Technologies

APPENDIX E

BOREHOLE RECORDS

APPENDIX E
BOREHOLE RECORDS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

BOREHOLE	SAMPLE NUMBER	SAMPLE DEPTH in meters	DESCRIPTION
1	1	0.6 to 1.2	FILL: Top half of sample: Brown sand Bottom half of sample: Grey ash with some black ash and coal, no odour
	2	1.2 to 1.8	FILL: Brown sand, no odour
	3	1.8 to 2.4	FILL: Brown sand with silt and gravel, moist, no odour
	4	2.4 to 2.7	FILL: Brown silty sand with gravel, no odour, moist
	5	2.7 to 3.3	FILL: Brown silty sand with gravel, grades to black silt with coal tar evident. Strong coal tar odour
	6	3.3 to 3.6	FILL: Brown sand with black oily silt, moist, Strong coal tar odour
	7	3.6 to 4.2	Brown silty sand with gravel, no odour, saturated
	8	4.2 to 4.8	Brown silty sand with gravel, no odour, saturated
	Refusal at 4.82 meters. Auger bit coated with liquid coal tar product.		
2	1	0.6 to 1.2	FILL: Brown silty sand. Little sample recovery
	2	1.2 to 1.8	FILL: Brown silty sand with brick fragments, moist
	3	1.8 to 2.4	FILL: Brown silty sand with brick fragments. Oily residue on sample, diesel type odour.
		2.4 to 3.0	No sample
	4	3.0 to 3.6	Brown silty sand with liquid coal tar. Sample Saturated
	Refusal at 3.7 meters. Stopped augering due to presence of liquid coal tar .		

APPENDIX E
BOREHOLE RECORDS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

BOREHOLE	SAMPLE NUMBER	SAMPLE DEPTH In meters	DESCRIPTION
3	1	0.6 to 1.2	FILL: Brown silty sand with brick fragments, diesel odour, moist
	2	1.2 to 1.8	FILL: Brick fragments and Black silty sand, varsol type odour
	3	1.8 to 2.4	FILL: Black silty sand with coal tar odour, moist
	4	2.4 to 3.0	Brown silty sand with gravel. Liquid coal tar evident
	Refusal at 3.0 meters. Did not continue to drill since coal tar evident.		
4	1	0.6 to 1.2	Brown silty sand with a mild coal tar odour, dry
	2	1.2 to 1.8	Brown silty sand with a mild coal tar odour, dry
	3	1.8 to 2.4	Black sand and silt with a coal tar odour, dry
	4	2.4 to 3.0	Brown silty sand with some liquid coal tar in fractures
	5	3.0 to 3.6	Green/Brown silty sand with liquid coal tar evident in the fractures
	6	3.6 to 4.2	Green/Brown silty sand with liquid coal tar evident in the fractures
	7	4.2 to 4.35	Poor sample recovery.
	Auger refusal at 4.35 meters		
5	1	0.6 to 1.2	Brown silty sand, dry. Green grey ash at base of sample
	2	1.2 to 1.8	Black slag and ash with a hydrocarbon odour, dry
	3	1.8 to 2.4	White ash and brick fragments, no odour, dry
	4	2.4 to 3.0	Brown silty sand moist, dry
	5	3.0 to 3.6	Red/brown silty sand, no odour, moist
	6	3.6 to 4.2	Grey silty sand with organics and iron oxide, some liquid coal tar evident. Strong coal tar odour
	7	4.2 to 4.8	Green silty sand with gravel, moist, mild coal tar odour

APPENDIX E
BOREHOLE RECORDS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

BOREHOLE	SAMPLE NUMBER	SAMPLE DEPTH in meters	DESCRIPTION
5	8	4.8 to 5.4	Green silty sand with gravel, very moist, coal tar odour
	9	5.4 to 6.0	Grey brown silty sand with a faint coal tar odour, saturated
	Completed hole about one meter below water table		
6	1	0.6 to 1.2	Brown silty sand with gravel, moist, (Granular B)
	2	1.2 to 1.8	Brown silty sand, moist, no odour
	3	1.8 to 1.98	Brown silty sand, moist, no odour
	Refusal at 1.98 meters probably bedrock		
7	1	0.6 to 1.2	Brick fragments
	2	1.2 to 1.8	Coal and brick fragments, brown silty sand with slag, moist, no odour
	3	1.8 to 2.4	Brown silty sand with slag and brick fragments. Little sample recovery, saturated, no odour
	4	2.4 to 3.0	Brown silty sand with slag, brick and coal fragments, moist
	5	3.0 to 3.6	Brown silty sand with liquid coal tar in fractures
	Refusal at 3.7 meters, drilling stopped		
8	1	0.6 to 1.2	Grey silty sand with brick fragments and cinders, faint coal tar odour, dry
	2	1.2 to 1.8	Grey silty sand with brick fragments, no odour, dry
	3	1.8 to 2.4	Green silty sand, dry, no odour
	4	2.4 to 3.0	Grey/brown silty sand, moist, Liquid coal tar in fractures
	5	3.0 to 3.6	Brown/green sand, moist, coal tar odour evident
	Encountered a solid object at 3.65 meters, stopped drilling and instrumented hole		

APPENDIX E
BOREHOLE RECORDS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

BOREHOLE	SAMPLE NUMBER	SAMPLE DEPTH In meters	DESCRIPTION
9	1	0.6 to 1.2	Brown silty sand with brick fragments and gravel, dry, no odour
	2	1.2 to 1.8	Brown silty sand with brick fragments and gravel, dry, no odour
	3	1.8 to 2.4	Brown sand with gravel, dry, no odour
	4	2.4 to 3.0	Brown and black sand with gravel and some black ash, faint sooty odour evident, dry
	5	3.0 to 3.6	Fine brown sand with grey and black ash, minor brick fragment sand layers of silty clay, faint coal tar odour, moist
		3.6 to 4.2	no sample
	6	4.2 to 4.8	Dark grey silty sand with silty clay, saturated, no odour
	7	4.8 to 5.4	Gravel and sand, saturated, no odour
10	1	0.6 to 1 2	Brown silty sand with brick fragments, no odour, dry. Minor iron oxide present
	2	1.2 to 1.8	Brown silty sand with brick fragments. Dry with a slight coal tar odour evident
	3	1.8 to 2.4	Brown silty sand, moist with brick and wood fragments. Mild coal tar odour
	4	2.4 to 3.0	Green silty sand with some black slag, moist, mild coal tar odour.
	5	3. 0 to 3.6	Green silty sand with some black slag, moist, mild coal tar odour.
	6	3 6 to 4.2	Dark brown silty sand, dry with wood fragments. no odour
	7	4.2 to 4.8	Wood, Saturated, poor sample recovery, mild coal tar odour

Drilling stopped and hole instrumented

APPENDIX E
BOREHOLE RECORDS
BROCKVILLE COAL GASIFICATION SITE
MINISTRY OF THE ENVIRONMENT

BOREHOLE	SAMPLE NUMBER	SAMPLE DEPTH In meters	DESCRIPTION
1 1	1	0.6 to 1.2	Brown fine sand, dry
		1.2 to 1.8	Concrete, no sample
	2	1.8 to 2.4	Brown silty sand with clay and gravel, no odour, dry
	3	2.4 to 3.0	Brown silty sand with wood fragments
	4	3.0 to 3.6	Green/brown silty sand with wood, ash, slag, dry, no odour
	5	3.6 to 4.2	Brown silty sand with ash, gravel, no odour, dry
	6	4.2 to 4.8	Brown sand with gravel, saturated, little sample recovery
	7	4.8 to 5.4	No sample recovery
	Installed screen to 5.4 meters		
1 2	1	0.6 to 1.2	Brown sand and gravel, well compacted (Granular B)
	2	1.2 to 1.8	Grey clayey silt with black ash and wood fragments, no odour
	3	1.8 to 2.4	Brown silty sand with grey ash and wood fragments no odour
	4	2.4 to 3.0	Black silty sand with gravel, moist, mild coal tar odour
	5	3.0 to 3.6	Dark brown silty sand with wood fragments, slag, moist, faint coal tar odour
	6	3.6 to 4.2	Rusty brown peat with grey clayey silt, wood fragments and organics, moist, no odour
	7	4.2 to 4.8	Grey clayey silt, moist, no odour
	8	4.8 to 5.4	Grey silty sand, saturated
	Refusal at 5.4 meters, assume bedrock		

APPENDIX F

CERTIFICATES OF ANALYSIS

APPENDIX F

Reported differences in the mdl (method detection limit) between field samples and lab blanks reflect cleaner samples for lab blanks. A lower mdl is to be expected with a cleaner sample.

Reported percent recoveries refer to lab blanks and field samples to which deuterized standards have been added for quality control purposes in order to provide the laboratory with control data on the efficiency and effectiveness of laboratory procedures.

Catalogue of Contents

F.1	Lab Water Blank	Blank	June 6, 1988	Volatiles
F.2	BH 1-5; BH 2-4; BH 4-5; BH 7-5	Soil	June 6, 1988	Volatiles
F.3	BH 1-5; BH 2-4	Soil	June 24, 1988	PAH's
F.4	BH 1-5 (repeat)	Soil	July 11, 1988	PAH's
F.5	BH 4-5; BH 7-5	Soil	June 24, 1988	PAH's
	SSS	Storm sewer sediment	June 24, 1988	PAH's
F.6	SSS	Storm sewer sediment	June 6, 1988	Volatiles
	STSS1; STSS2; STSS3	Stream sediment	June 6, 1988	Volatiles
F.7	STSS1; STSS2; STSS3	Stream sediment	June 24, 1988	PAH's
F.8	Sediment #1	Stream sediment	Nov 22,1988	Volatiles
F.9	Sediment #1	Stream sediment	Jan 3, 1989	PAH's
F.10	BH 1; BH 5; BH 7; BH 11	Monitoring well liquids	May 19, 1988	ICAP metals
F.11	BH 1; BH 5; BH 7; BH 11	Monitoring well liquids	May 26, 1988	Volatiles & General Chemistry
F.12	BH 11; BH 5; BH 1; BH 7	Monitoring well liquids	June 14, 1988	PAH's
F.13	BH 7	Groundwater	Jan 3, 1989	PAH's
	WSDS	Stream water	Jan 3, 1989	PAH's
F.14	BH 1	Groundwater	Jan 5, 1989	PAH's
	WSUS	Stream water	Jan 5, 1989	PAH's
F.15	BH 1; BH 7	Groundwater	Jan 3, 1989	General Chemistry
	WSUS; WSDS	Stream water	Jan 3, 1989	General Chemistry

1018-1

VOLATILE ORGANICS

TROW DAMES & MOORE

Conc. = ppb

VOLATILE COMPOUNDS	MDL (ppb)	LAB WATER BLANK				
DICHLORODIFLUOROMETHANE	2.0	--	--	--	--	--
CHLOROMETHANE	2.0	--	--	--	--	--
VINYL CHLORIDE	2.0	--	--	--	--	--
BROMOMETHANE	2.0	--	--	--	--	--
CHLOROETHANE	2.0	--	--	--	--	--
TRICHLOROFLUOROMETHANE	2.0	--	--	--	--	--
1,1-DICHLOROETHYLENE	1.0	--	--	--	--	--
DICHLOROMETHANE	1.0	TR	--	--	--	--
T-1,2-DICHLOROETHYLENE	1.0	--	--	--	--	--
1,1-DICHLOROETHANE	1.0	--	--	--	--	--
CHLOROFORM	1.0	2.07	--	--	--	--
1,2-DICHLOROETHANE	1.0	--	--	--	--	--
1,1,1-TRICHLOROETHANE	1.0	--	--	--	--	--
BENZENE	0.5	TR	--	--	--	--
CARBON TETRACHLORIDE	1.0	--	--	--	--	--
1,2-DICHLOROPROPANE	1.0	--	--	--	--	--
BROMODICHLOROMETHANE	1.0	--	--	--	--	--
TRICHLOROETHYLENE	1.0	--	--	--	--	--
1,3-DICHLOROPROPENE(Z)	1.0	--	--	--	--	--
1,3-DICHLOROPROPENE(E)	1.0	--	--	--	--	--
1,1,2-TRICHLOROETHANE	1.0	--	--	--	--	--
TOLUENE	0.5	--	--	--	--	--
DIBROMOCHLOROMETHANE	1.0	--	--	--	--	--
TETRACHLOROETHYLENE	1.0	--	--	--	--	--
CHLOROBENZENE	0.5	--	--	--	--	--
ETHYL BENZENE	0.5	--	--	--	--	--
P & M XYLENE	0.5	--	--	--	--	--
BROMOFORM	1.0	--	--	--	--	--
O-XYLENE	0.5	--	--	--	--	--
1,1,2,2-TETRACHLOROETHANE	1.0	--	--	--	--	--
1,3-DICHLOROBENZENE	1.0	--	--	--	--	--
1,4-DICHLOROBENZENE	1.0	--	--	--	--	--
1,2-DICHLOROBENZENE	1.0	--	--	--	--	--
CIS-1,2-DICHLOROETHYLENE	1.0	--	--	--	--	--
% RECOVERY						
4-BROMOFLUOROMETHANE		101.51				

TR = TRACE AMOUNT DETECTED

-- = NONE DETECTED

MDL = METHOD DETECTION LIMIT

ANALYST _____ 6/15

1018-3

VOLATILE ORGANICS — TROW DAMES & MOORE

Conc. = ppb

VOLATILE COMPOUNDS	MDL (ppb)	BH1-5	BH2-4	BH4-5	BH7-5
DICHLORODIFLUOROMETHANE	200	--	--	--	--
CHLOROMETHANE	200	--	--	--	--
VINYL CHLORIDE	200	--	--	--	--
BROMOMETHANE	200	--	--	--	--
CHLOROETHANE	200	--	--	--	--
TRICHLOROFLUOROMETHANE	200	--	--	--	--
1,1-DICHLOROETHYLENE	100	--	--	--	--
DICHLOROMETHANE	100	--	--	--	--
T-1,2-DICHLOROETHYLENE	100	--	--	--	--
1,1-DICHLOROETHANE	100	--	--	--	--
CHLOROFORM	100	TR	--	--	880.02
1,2-DICHLOROETHANE	100	--	--	--	--
1,1,1-TRICHLOROETHANE	100	--	655.63	--	--
BENZENE	50	--	--	--	44.14 ppm
CARBON TETRACHLORIDE	100	--	--	--	--
1,2-DICHLOROPROPANE	100	--	--	--	--
BROMODICHLOROMETHANE	100	--	--	--	--
TRICHLOROETHYLENE	100	--	--	--	--
1,3-DICHLOROPROPENE(Z)	100	--	--	--	--
1,3-DICHLOROPROPENE(E)	100	--	--	--	--
1,1,2-TRICHLOROETHANE	100	--	--	--	--
TOLUENE	50	--	--	--	91.8 ppm
DIBROMOCHLOROMETHANE	100	--	--	--	--
TETRACHLOROETHYLENE	100	--	--	--	--
CHLOROBENZENE	50	--	--	--	--
ETHYL BENZENE	50	--	110.17	--	339.28 ppm
P & M XYLENE	50	--	133.50	142.21	308.23 ppm
BROMOFORM	100	--	--	--	--
O-XYLENE	50	--	81.77	786.75	153.38 ppm
1,1,2,2-TETRACHLOROETHANE	100	--	--	--	--
1,3-DICHLOROBENZENE	100	--	--	--	--
1,4-DICHLOROBENZENE	100	--	--	--	--
1,2-DICHLOROBENZENE	100	--	--	--	--
CIS-1,2-DICHLOROETHYLENE	100	--	--	--	--
*OTHER COMPOUNDS DETECTED					
TOTAL C3-BENZENES		5.85 ppm	5.8 ppm	10.58 ppm	319.08 ppm
TOTAL C4-BENZENES		5.80 ppm	2.35 ppm	13.05 ppm	236.15 ppm
NAPHTHALENE		197.8 ppb	17.61 ppm	12.73 ppm	152.11 ppm
STYRENE					717.65 ppb
% RECOVERY					
4-BROMOFLUOROMETHANE		99.62%	91.7%	94.22%	111.24%

TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED
MDL = METHOD DETECTION LIMIT
* SEMI-QUANTITATIVE VALUES ONLY

ANALYST _____ / June 6/88

1018-P1

POLYNUCLEAR AROMATIC HYDROCARBONS

TROW HYDROLOGY

CONC = ug/g

W.O. 881018

COMPOUND	% RECOVERY SPIKE	EX. BLK. (ppm)	MDL (ppm)	BH 1-5 (ppm)	MDL (ppm)	BH 2-4 (ppm)
NAPHTHALENE	61.6	--	0.1	2.8	0.4	77.3
ACENAPHTHYLENE	71.1	--	0.1	2.5	0.4	11.6
ACENAPHTHENE	70.4	--	0.1	0.4	0.4	1.4
9H FLUORENE	72.7	--	0.08	1.4	0.3	4.9
PHENANTHRENE	78.7	--	0.08	3.0	0.3	14.4
ANTRACENE	83.0	--	0.08	1.3	0.3	4.6
FLUORANTHENE	86.1	--	0.08	2.5	0.3	5.4
PYRENE	87.1	--	0.08	>4.6+	0.3	8.1
CHRYSENE	85.9	--	0.4	1.9*	1.7	1.8*
BENZO(a)ANTHRACENE	87.5	--	0.4	2.3	1.7	TR
BENZO(b)FLUORANTHENE	84.4	--	0.4	2.9'	1.7	2.4'
BENZO(k)FLUORANTHENE	86.7	--	0.4	--	1.7	--
BENZO(a)PYRENE	85.8	--	0.4	3.9	1.7	2.2
PERYLENE	82.0	--	0.4	0.6	1.7	TR
INDENO(123-cd)PYRENE	91.9	--	0.4	1.5	1.7	TR
DIBENZO(ah)ANTHRACENE	80.8	--	0.4	3.8	1.7	--
BENZO(ghi)PERYLENE	83.5	--	0.4	0.9	1.7	TR
% RECOVERY						
D8 NAPHTHALENE	55.7	58.0	--	58.8	--	57.0
D10 ANTHRACENE	75.3	69.5	--	86.9	--	80.1
D12 BENZO(a)PYRENE	73.5	65.8	--	84.4	--	79.7

MDL = METHOD DETECTION LIMIT

-- = NOT DETECTED

TR = TRACE

+ = CONCENTRATION OF PYRENE IS BEYOND RANGE OF CALIBRATION TABLE

* = MEETS RETENTION TIME AND 2 IONS OUT OF THREE ION QUALIFIERS

' = CONCENTRATION OF BENZO(B)FLUORANTHENE & BENZO(K) FLUORANTHENE IS COMBINED

ANALYST

1018-P1

POLYNUCLEAR AROMATIC HYDROCARBONS

TROW HYDROLOGY

CONC = ug/g

W.O. 881018

COMPOUND	% RECOVERY SPIKE	EX. BLK. (ppm)	MDL (ppm)	BH 1-5 (ppm)
NAPHTHALENE	61.6	--	0.1	2.8
ACENAPHTHYLENE	71.1	--	0.1	2.5
ACENAPHTHENE	70.4	--	0.1	0.4
9H FLUORENE	72.7	--	0.08	1.4
PHENANTHRENE	78.7	--	0.08	3.0
ANTRACENE	83.0	--	0.08	1.3
FLUORANTHENE	86.1	--	0.08	2.5
PYRENE	87.1	--	0.08	8.0
CHRYSENE	85.9	--	0.4	1.9*
BENZO(a)ANTHRACENE	87.5	--	0.4	2.3
BENZO(b)FLUORANTHENE	84.4	--	0.4	2.9'
BENZO(k)FLUORANTHENE	86.7	--	0.4	--
BENZO(a)PYRENE	85.8	--	0.4	3.9
PERYLENE	82.0	--	0.4	0.6
INDENO(123-cd)PYRENE	91.9	--	0.4	1.5
DIBENZO(ah)ANTHRACENE	80.8	--	0.4	3.8
BENZO(ghi)PERYLENE	83.5	--	0.4	0.9
% RECOVERY				
D8 NAPHTHALENE	55.7	58.0	--	58.8
D10 ANTHRACENE	75.3	69.5	--	86.9
D12 BENZO(a)PYRENE	73.5	65.8	--	84.4

MDL = METHOD DETECTION LIMIT

-- = NOT DETECTED

TR = TRACE

* = MEETS RETENTION TIME AND 2 IONS OUT OF THREE ION QUALIFIERS

' = CONCENTRATION OF BENZO(B)FLUORANTHENE & BENZO(K) FLUORANTHENE IS COMBINED

ANALYST

1018-P2

POLYNUCLEAR AROMATIC HYDROCARBONS

TROW HYDROLOGY

CONC = ug/g

W.O. 881018

COMPOUND	MDL (ppm)	BH 4-5 (ppm)	MDL (ppm)	BH 7-5 (ppm)	MDL (ppm)	SS 5
NAPHTHALENE	0.1	1.0	60.	7000	0.2	--
ACENAPHTHYLENE	0.1	0.7	60.	633	0.2	--
ACENAPHTHENE	0.1	1.0	60.	1120	0.2	--
9H FLUORENE	0.07	0.5	40.	1150	0.1	--
PHENANTHRENE	0.07	1.9	40.	3130	0.1	TR
ANTRACENE	0.07	0.7	40.	775	0.1	--
FLUORANTHENE	0.07	0.9	40.	1050	0.1	TR
PYRENE	0.07	1.0	40.	1320	0.1	TR
CHRYSENE	0.4	0.6	210.	446	0.7	TR
BENZO(a)ANTHRACENE	0.4	0.7	210.	380	0.7	TR
BENZO(b)FLUORANTHENE	0.4	1.8!	210.	519!	0.7	TR
BENZO(k)FLUORANTHENE	0.4				0.7	
BENZO(a)PYRENE	0.4	1.3	210.	382	0.7	TR
PERYLENE	0.4	TR	210.	TR	0.7	--
INDENO(123-cd)PYRENE	0.4	0.9	210.	TR	0.7	--
DIBENZO(ah)ANTHRACENE	0.4	0.4	210.	TR	0.7	--
BENZO(ghi)PERYLENE	0.4	0.9	210.	TR	0.7	--
% RECOVERY						
D8 NAPHTHALENE	--	NA	--	49.0	--	32.5
D10 ANTHRACENE	--	NA	--	UD	--	65.2
D12 BENZO(a)PYRENE	--	NA	--	86.3	--	52.3

MDL = METHOD DETECTION LIMIT

-- = NOT DETECTED

TR = TRACE

NA = NOT ADDED

UD = UNABLE TO DETERMINE DUE TO HIGH CONCENTRATION OF NATURAL PHENANTHRENE AND ANTHRACENE

\+ = CONCENTRATION OF PYRENE IS BEYOND RANGE OF CALIBRATION TABLE

* = MEETS RETENTION TIME AND 2 IONS OUT OF THREE ION QUALIFIERS

! = CONCENTRATION OF BENZO(B)FLUORANTHENE & BENZO(K) FLUORANTHENE IS COMBINED

ANALYST A Matthews / June 24 '88

1018-2

VOLATILE ORGANICS

TROW DAMES & MOORE

Conc. = ppb

VOLATILE COMPOUNDS	MDL (ppb)	SSS	STSS1	STSS2	STSS3
DICHLORODIFLUOROMETHANE	20	--	--	--	--
CHLOROMETHANE	20	--	--	--	--
VINYL CHLORIDE	20	--	--	--	--
BROMOMETHANE	20	--	--	--	--
CHLOROETHANE	20	--	--	--	--
TRICHLOROFLUOROMETHANE	20	--	--	--	--
1,1-DICHLOROETHYLENE	10	--	--	--	--
DICHLOROMETHANE	10	--	--	TR	TR
T-1,2-DICHLOROETHYLENE	10	--	--	--	--
1,1-DICHLOROETHANE	10	--	--	--	--
CHLOROFORM	10	--	--	--	--
1,2-DICHLOROETHANE	10	--	--	--	--
1,1,1-TRICHLOROETHANE	10	--	--	--	--
BENZENE	5	--	--	--	--
CARBON TETRACHLORIDE	10	--	--	--	--
1,2-DICHLOROPROPANE	10	--	--	--	--
BROMODICHLOROMETHANE	10	--	--	--	--
TRICHLOROETHYLENE	10	--	--	--	--
1,3-DICHLOROPROPENE(Z)	10	--	--	--	--
1,3-DICHLOROPROPENE(E)	10	--	--	--	--
1,1,2-TRICHLOROETHANE	10	--	--	--	--
TOLUENE	5	5.54	67.32	--	--
DIBROMOCHLOROMETHANE	10	--	--	--	--
TETRACHLOROETHYLENE	10	--	--	--	--
CHLOROBENZENE	5	--	--	--	--
ETHYL BENZENE	5	--	--	--	--
P & M XYLENE	5	--	--	--	--
BROMOFORM	10	--	--	--	--
O-XYLENE	5	--	--	--	--
1,1,2,2-TETRACHLOROETHANE	10	--	--	--	--
1,3-DICHLOROBENZENE	10	--	--	--	--
1,4-DICHLOROBENZENE	10	--	--	--	--
1,2-DICHLOROBENZENE	10	--	--	--	--
CIS-1,2-DICHLOROETHYLENE	10	--	--	--	--
% RECOVERY					
4-BROMOFLUOROMETHANE		89.31%	99.49%	89.36%	95.75%

TR = TRACE AMOUNT DETECTED

-- = NONE DETECTED

MDL = METHOD DETECTION LIMIT

ANALYST [illegible] / [illegible] 6/18

1018-P3

POLYNUCLEAR AROMATIC HYDROCARBONS

TROW HYDROLOGY

CONC = ug/g

W.O. 881018

COMPOUND	MDL (ppm)	STSS1 (ppm)	MDL (ppm)	STSS2 (ppm)	MDL (ppm)	STSS3 (ppm)
NAPHTHALENE	0.1	--	0.2	--	0.05	--
ACENAPHTHYLENE	0.1	--	0.2	0.2	0.05	--
ACENAPHTHENE	0.1	--	0.2	--	0.05	TR
9H FLUORENE	0.1	--	0.1	--	0.03	0.04
PHENANTHRENE	0.1	TR	0.1	TR	0.03	0.2
ANTRACENE	0.1	--	0.1	TR	0.03	0.05
FLUORANTHENE	0.1	0.2	0.1	TR	0.03	0.4
PYRENE	0.1	0.2	0.1	TR	0.03	0.4
CHRYSENE	0.6	TR	0.8	TR*	0.2	TR
BENZO(a)ANTHRACENE	0.6	TR	0.8	TR	0.2	TR
BENZO(b)FLUORANTHENE	0.6	0.6!	0.8	TR!	0.2	TR
BENZO(k)FLUORANTHENE	0.6		0.8		0.2	TR
BENZO(a)PYRENE	0.6	TR	0.8	TR	0.2	TR
PERYLENE	0.6		0.8		0.2	--
INDENO(123-cd)PYRENE	0.6	TR	0.8	TR	0.2	TR
DIBENZO(ah)ANTHRACENE	0.6		0.8		0.2	--
BENZO(ghi)PERYLENE	0.6	TR	0.8	TR	0.2	TR
% RECOVERY						
D8 NAPHTHALENE		45.9		17.2		25.2
D10 ANTHRACENE		72.8		41.7		80.1
D12 BENZO(a)PYRENE		71.0		49.6		75.8

MDL = METHOD DETECTION LIMIT

-- = NOT DETECTED

TR = TRACE

* = MEETS RETENTION TIME AND 2 IONS OUT OF THREE ION QUALIFIERS

! = CONCENTRATION OF BENZO(B) FLUORANTHENE & BENZO(K) FLUORANTHENE IS COMBINED

ANALYST N Pinsker, June 24 1988

3870-1

TROW DAMES & MOORE
W.O. #883870

VOLATILE ORGANICS
Conc. = (ppb)

VOLATILE COMPOUNDS	MDL (ppb)	LAB WATER BLANK	MDL (ppb)	SEDIMENT #1	
DICHLORODIFLUOROMETHANE	2.0	--	100	--	--
CHLOROMETHANE	2.0	--	100	--	--
VINYL CHLORIDE	2.0	--	100	--	--
BROMOMETHANE	2.0	--	100	--	--
CHLOROETHANE	2.0	--	100	--	--
TRICHLOROFLUOROMETHANE	2.0	--	100	--	--
1,1-DICHLOROETHYLENE	1.0	--	50	--	--
DICHLOROMETHANE	1.0	--	50	--	--
T-1,2-DICHLOROETHYLENE	1.0	--	50	--	--
1,1-DICHLOROETHANE	1.0	--	50	--	--
CHLOROFORM	1.0	4.20	50	--	--
1,2-DICHLOROETHANE	1.0	--	50	--	--
1,1,1-TRICHLOROETHANE	1.0	--	50	--	--
BENZENE	0.5	--	25	--	--
CARBON TETRACHLORIDE	1.0	--	50	--	--
1,2-DICHLOROPROPANE	1.0	--	50	--	--
BROMODICHLOROMETHANE	1.0	--	50	--	--
TRICHLOROETHYLENE	1.0	--	50	--	--
1,3-DICHLOROPROPENE(Z)	1.0	--	50	--	--
1,3-DICHLOROPROPENE(E)	1.0	--	50	--	--
1,1,2-TRICHLOROETHANE	1.0	--	50	--	--
TOLUENE	0.5	TR	25	--	--
DIBROMOCHLOROMETHANE	1.0	--	50	--	--
TETRACHLOROETHYLENE	1.0	--	50	--	--
CHLOROBENZENE	0.5	--	25	--	--
ETHYL BENZENE	0.5	--	25	--	--
P & M XYLENE	0.5	--	25	--	--
BROMOFORM	1.0	--	50	--	--
O-XYLENE	0.5	--	25	--	--
1,1,2,2-TETRACHLOROETHANE	1.0	--	50	--	--
1,3-DICHLOROBENZENE	1.0	--	50	--	--
1,4-DICHLOROBENZENE	1.0	--	50	--	--
1,2-DICHLOROBENZENE	1.0	--	50	--	--
CIS-1,2-DICHLOROETHYLENE	1.0	--	50	--	--
*OTHER COMPOUNDS DETECTED					
TOTAL C3-BENZENES	--	--	-	96.4	--
TOTAL C4-BENZENES	--	--	-	1.09 ppm	--
1-ETHYLIDENE-1H-INDENE	--	--	-	163.08 ppb	--
SURROGATE % RECOVERY					
4-BROMOFLUOROBENZENE	--	103.3%	-	111.52%	--

* = SEMI-QUANTITATIVE VALUES ONLY
TR = TRACE AMOUNT DETECTED
-- = NONE DETECTED
MDL = METHOD DETECTION LIMIT

ANALYST [illegible] / Nov. 22/88

PAH-TEM
3870-P1

POLYNUCLEAR AROMATIC HYDROCARBONS
TROW
MTL W.O. # 883870

CONC = ug/g (dry wt)

SEDIMENT

COMPOUND	MDL	% RECOVERY	EXTRACTION BLANK	MDL	SEDIMENT #1
NAPHTHALENE	0.2	32.3	-	2.0	3.33
ACENAPHTHYLENE	0.2	37.1	-	2.0	7.80
ACENAPHTHENE	0.2	38.7	-	2.0	110.0
9H FLUORENE	0.2	42.5	-	2.0	57.4
PHENANTHRENE	0.1	56.3	-	5.0	137.0
ANTHRACENE	0.1	57.2	-	5.0	45.5
FLUORANTHENE	0.1	79.2	-	5.0	49.5
PYRENE	0.1	79.9	-	5.0	69.7
BENZO(a)ANTHRACENE	0.1	55.5	-	1.0	35.3
CHRYSENE	0.1	58.8	-	1.0	33.9
BENZO(b)FLUORANTHENE	0.2	74.6	-	1.0	30.6*
BENZO(k)FLUORANTHENE	0.2	77.3	-	1.0	*
BENZO(e)PYRENE	0.2	82.6	-	1.0	19.8
PERYLENE	0.2	76.0	-	1.0	1.91
INDENO(123-cd)PYRENE	0.2	84.1	-	1.0	9.4
DIBENZO(ah)ANTHRACENE	0.2	79.4	-	1.0	1.63
BENZO(ghi)PERYLENE	0.2	74.8	-	1.0	1.79
% RECOVERY					
D8 NAPHTHALENE	-	26.6	27.5	-	21.5
D10 ANTHRACENE	-	68.8	75.9	-	92.9
D12 BENZO(a)PYRENE	-	79.0	74.0	-	71.0

* = THE CONCENTRATION OF BENZO(B)FLUORANTHENE AND BENZO(K)FLUORANTHENE ARE COMBINED

MDL = METHOD DETECTION LIMIT
- = NOT DETECTED

ANALYST [signature] Jan 3 1989

MANN TESTING LABORATORIES LTD

TECHNICAL SERVICE LABORATORIES
1301 FEWSTER DRIVE, MISSISSAUGA, ONTARIO L4W 1A2
TELEPHONE : (416) 625 - 1544

I.C.A.P. PLASMA SCAN

Water Samples

TROW DAMES & MOORE
1595 CLARK BLVD.
BRAMPTON ONTARIO
L6T 4V1
YOUR REFERENCE - P. DUCKWORTH

T.S.L. REPORT No. : T - 6437
T.S.L. File No. : C:\SC\MAY19A.DN
T.S.L. Invoice No. :

ALL RESULTS IN MG/L

ELEMENT		BH 1	BH 5	BH 7	BH 11
Aluminum	(Al)	2600	32	2000	1200
Antimony	(Sb)	2	< 0.13	2	< 2
Barium	(Ba)	33	0.61	22	11
Beryllium	(Be)	0.1	< 0.0065	0.1	< 0.1
Boron	(B)	< 10	0.65	< 10	< 10
Calcium	(Ca)	31000	580	14000	4400
Cadmium	(Cd)	< 0.1	0.0065	< 0.1	< 0.1
Chromium	(Cr)	3.6	0.078	5.4	2.6
Cobalt	(Co)	4.6	0.091	2.8	1.2
Copper	(Cu)	10	0.14	12	6.2
Iron	(Fe)	6800	67	5100	2300
Lead	(Pb)	2	0.13	19	5
Magnesium	(Mg)	6200	150	3600	1600
Manganese	(Mn)	170	2.2	110	68
Molybdenum	(Mo)	0.4	0.052	0.4	< 0.4
Nickel	(Ni)	9.2	0.23	7.2	2.4
Phosphorus	(P)	230	1.9	170	68
Potassium	(K)	2600	64	1500	860
Scantium	(Sc)	1.1	0.01	0.76	0.52
Silicon	(Si)	360	49	190	290
Silver	(Ag)	< 0.4	0.052	0.4	< 0.4
Sodium	(Na)	450	49	200	170
Strontium	(Sr)	37	2.1	16	6.8
Tin	(Sn)	< 2	< 0.13	< 2	2
Titanium	(Ti)	180	1.6	120	84
Vanadium	(V)	14	0.078	5.2	3
Yetterium	(Y)	4	0.039	2.4	1.8
Zinc	(Zn)	28	0.29	21	6.4
Zirconium	(Zr)	0.2	0.039	0.4	0.6

DATE : MAY-19-1988

SIGNED : _____

JUN 2 7 1988

TECHNICAL SERVICE LABORATORIES
DIVISION OF BURGENER TECHNICAL ENTERPRISES LIMITED
1301 FEWSTER DRIVE
MISSISSAUGA ONTARIO
L4W 1A2
(416) 625 1544 FAX (416) 625 8368

CERTIFICATE OF ANALYSIS

SAMPLE(S) FROM
Trow Dames & Moore
1595 Clark Blvd.
Brampton Ontario
L6T 4V1
Attn. P. B. Duckworth

REPORT No
T6437-1

SAMPLE(S) OF
Water

INV # 45842
P.O. 10044-003

Proj. 10044-003 Water	BH 1	BH 5	BH 7	BH 11
pH	7.9	7.7	7.4	7.8
Alkalinity mg/L	937	200	535	505
Bicarbonate mg/L	1142	244	653	616
Sulphate mg/L	990	450	570	123
Sulphide mg/L	< 0.01	< 0.01	0.02	< 0.01
Chloride mg/L	1225	105	450	280
Cyanide mg/L	< 0.1	< 0.1	0.3	< 0.1
Ammonium as N mg/L	< 0.1	< 0.1	2.0	< 0.1
TKN mg/L	< 0.1	< 0.1	2.3	< 0.1
COD mg/L	57	32	180	40
TDC mg/L	245	48	128	121
Phenols mg/L	0.150	< 0.001	1.50	0.014
Benzene mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Toluene mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Xylene mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Plasma Scan	Attached	Attached	Attached	Attached

MAY 26 1988

SIGNED

For enquiries on this report please contact Customer Service Department.
Samples, Pulps and Rejects discarded two months from the date of this report.

TECHNICAL SERVICE LABORATORIES
DIVISION OF BURGENER TECHNICAL ENTERPRISES LIMITED
3080 FEWSTER DRIVE
MISSISSAUGA ONTARIO
L4W 1A2
(416) 625-1544 FAX (416) 625 8368

CERTIFICATE OF ANALYSIS

SAMPLE(S) FROM

Trow Dames & Moore
1595 Clark Blvd.
Brampton, Ontario
L6T 4V1
Attn: Peter Duckworth

REPORT No
T-6965

SAMPLE(S) OF

WATER

PO#10044003

Job #10044003 010688	BH11	BH5	BH1	BH7	% Recovery Spike Level
Naphthalene ppb	2.54	5.39	6034	9995	105
Acenaphthylene ppb	9.31	1.60	3733	2896	111
Acenaphthene ppb	1.24	0.48	220.9	1362	77
Fluorene ppb	3.30	0.57	839.6	1502	98
Phenanthrene ppb	11.28	1.50	2008	3515	92
Anthracene ppb	5.00	0.64	936.3	1630	88
Fluoranthene ppb	23.08	1.72	929.7	2111	97
Pyrene ppb	26.13	2.85	1261	2507	98
Benzo (a) anthrancene ppb	14.25	1.83	631.9	1573	96
Chrysene ppb	14.04	1.72	493.0	1497	89
Benzo (k) fluoranthane ppb	12.98	1.59	540.1	1315	86
Benzo (b) fluoranthene ppb	15.92	1.35	369.9	1053	85
Benzo (a) pyrene ppb	16.60	1.45	531.0	1936	75
Dibenzo (a,h) anthracene ppb	3.79	0.38	51.46	231.0	52
Indeno (1,2,3-cd) pyrene ppb	12.76	1.00	159.3	1115	51
Benzo (ghi) perylene ppb	10.49	0.85	159.1	1294	46
SURROGATES % RECOVERY					
D8-Naphthalene ppb	92	ND**	ND**		108
D12-Chrysene ppb	112	ND**	ND**		114

** Surrogate not detected because of dilution required.

June 14, 1988

SIGNED _____

CTA

For enquiries on this report, please contact Customer Service Department.
Samples, Pulps and Rejects discarded two months from the date of this report.

PAH-TEM
3870-P3

POLYNUCLEAR AROMATIC HYDROCARBONS
TROW
MTL W.O. # 883870

CONC = ug/l

COMPOUND	MDL	WSDS	MDL	BH-7
NAPHTHALENE	8.0	-	9.0	169
ACENAPHTHYLENE	4.0	-	4.5	26.2
ACENAPHTHENE	4.0	-	4.5	26.5
9H FLUORENE	4.0	-	4.5	17.2
PHENANTHRENE	2.0	-	2.3	12.1
ANTHRACENE	2.0	-	2.3	3.70
FLUORANTHENE	2.0	-	2.3	-
PYRENE	2.0	-	2.3	-
BENZO(a)ANTHRACENE	2.0	-	2.3	-
CHRYSENE	2.0	-	2.3	-
BENZO(b)FLUORANTHENE	4.0	-	4.5	-
BENZO(k)FLUORANTHENE	4.0	-	4.5	-
BENZO(a)PYRENE	4.0	-	4.5	-
PERYLENE	2.0	-	2.3	-
INDENO(123-cd)PYRENE	6.0	-	6.7	-
DIBENZO(ah)ANTHRACENE	4.0	-	4.5	-
BENZO(ghi)PERYLENE	4.0	-	4.5	-
% RECOVERY				
D8 NAPHTHALENE	-	45.0	-	43.5
D10 ANTHRACENE	-	87.0	-	87.6
D12 BENZO(a)PYRENE	-	77.0	-	86.5

MDL = METHOD DETECTION LIMIT
- = NOT DETECTED

ANALYST N Rawlings, Jan 3. 1989

PAH-TEM
3870-P2

POLYNUCLEAR AROMATIC HYDROCARBONS
TROW
MTL W.O. # 883870

CONC = ug/l

COMPOUND	MDL	% RECOVERY	EXTRACTION BLANK	MDL	BH-1	MDL	WSVS
NAPHTHALENE	1.0	59.4	-	10.0	369	4.0	-
ACENAPHTHYLENE	0.5	73.9	-	5.0	-	2.0	-
ACENAPHTHENE	0.5	72.5	-	5.0	-	2.0	-
9H FLUORENE	0.5	77.3	-	5.0	14.7	2.0	-
PHENANTHRENE	0.5	84.4	-	5.0	17.7	2.0	-
ANTHRACENE	0.5	85.3	-	5.0	-	2.0	-
FLUORANTHENE	0.5	93.7	-	5.0	-	2.0	-
PYRENE	0.5	95.5	-	5.0	-	2.0	-
BENZO(a)ANTHRACENE	0.5	111.0	-	5.0	-	2.0	-
CHRYSENE	0.5	109.0	-	5.0	-	2.0	-
BENZO(b)FLUORANTHENE	1.0	108.0	-	10.0	-	4.0	-
BENZO(k)FLUORANTHENE	1.0	95.4	-	10.0	-	4.0	-
BENZO(a)PYRENE	1.0	98.9	-	10.0	-	4.0	-
PERYLENE	1.0	99.0	-	10.0	-	4.0	-
INDENO(123-cd)PYRENE	3.0	90.2	-	30.0	-	10.0	-
DIBENZO(ah)ANTHRACENE	3.0	91.9	-	30.0	-	10.0	-
BENZO(ghi)PERYLENE	3.0	92.9	-	30.0	-	10.0	-
% RECOVERY							
D8 NAPHTHALENE	-	54.6	70.1	-	70.0	-	64.0
D10 ANTHRACENE	-	88.0	93.7	-	83.5	-	91.2
D12 BENZO(a)PYRENE	-	90.0	90.0	-	79.0	-	88.5

MDL = METHOD DETECTION LIMIT
- = NOT DETECTED

ANALYST N Armstrong Jan 3, 1988

MANN TESTING LABORATORIES LTD

3419-1

CLIENT: TROW, DAMES & MOORE
REF. NO.: 883419
TABLE: 1

CHEMICAL ANALYSIS - GENERAL
CONC = mg/L UNLESS OTHERWISE NOTED

CHEMICAL PARAMETERS	MDL (mg/L)	BH1	BH7	WSUS	WSDS
Hg	1.00	1.08	1.26	<1.00	<1.00
As	0.002	0.004	0.002	0.002	<0.002
Se	0.002	<0.002	<0.002	<0.002	<0.002
TKN	0.1	1.38	10.9	0.88	0.98
Ammonia	0.01	<0.5	6.8	0.46	0.46
Free Cyanide	0.02	0.03	0.02	<0.02	<0.02
pH	0.01	7.92	7.89	8.01	8.20
Conductivity (umho/cm)	0.1	167.2	166.5	164.7	164.2

MDL = INSTRUMENT/METHOD DETECTION LIMIT
NS = NON SUFFICIENT SAMPLE
-- = NO ANALYSIS REQUIRED